CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER 88-146

UPDATED WASTE DISCHARGE REQUIREMENTS

SHELL OIL COMPANY
MARTINEZ MANUFACTURING COMPLEX
MARTINEZ, CONTRA COSTA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, hereinafter called the Board, finds that:

1. Shell Oil Company, hereinafter called the discharger, owns and operates the Martinez Manufacturing Complex in Contra Costa County as shown in Figure 1. This petroleum refinery occupies a 1000 acre site on the south side of the Carquinez Strait. The refinery was established in 1913 as product terminal. Refining operations commenced at the site in 1916, and a chemical plant, used for the manufacture of secondary butyl alcohol, was built in 1931. The refinery currently maintains a crude-run throughput of 143,000 barrels of oil, and manufactures various hydrocarbon products including gasoline, intermediate fuels (jet, diesel, stove, kerosene), industrial fuels, spray oils, lubricants, and asphalts. The facility also manufactures gasoline additives and catalysts. The refinery has manufactured up to 50 different chemical products in the past, however most of the chemical product areas are currently inactive. Wastes generated from these processes have been disposed to various areas around the refinery in the past. This Order addresses the waste water treatment pond system, 4 storm water ponds, 18 inactive waste management units, and 9 areas of potential water quality concern.

2. The discharge of approximately 4.2 million gallons per day of process waste water from the facility is regulated by Board Order No. 85-22, NPDES Permit No. CA0005789. This Order has been amended by Board Orders No. 86-60, 87-10, and 87-100.

3. Geologically, the Martinez Manufacturing Complex is located along the east side of the Briones Hills, and partially on the alluvial plain/tidal flats of Suisun Bay on the south side of Carquinez Strait. The upland areas of the refinery consist of three northwest trending ridges (Crude, Middle, and Vine Hills) which are composed of the Martinez, Meganos, and Domengine Formations. The Martinez Formation is a light colored, thinly bedded sequence of siltstones and fine-grained sandstones. The Meganos Formation has been described as a fissile, dark grey shale, with minor siltstone, and sandy claystone. Numerous fractures, and slickensides were noted in unweathered samples. The Domengine Formation has been described as a light colored, very fine to fine grained, thickly bedded sandstone, with thin claystone interbeds. All of these formations dip approximately 50 degrees to the southwest. Fractures, joints and faults have been mapped in these units at the site.

Younger geologic units at the site include a unit of Older Alluvium which ranges from 30 to 900 feet thick across the site. This unit consists of interbedded clay, silt, and fine to coarse sand with pebbles. The channel deposits within this unit range from a few to tens of feet across.

The youngest units at the site consist of Quaternary sediments. Alluvial material, deposited during the Quaternary at low stands of the sea, is found at the site, as well as sand, peat, and clay, deposited by the present day bay/estuary system.

4. The refinery has been divided into 5 groundwater basins (Figure 2). These basins have been defined by site topography and groundwater elevation measurements in all the wells at the refinery. The Basins are designated, from west to east, as the Crude Hill Area, the West Valley Groundwater Basin, the Central Valley Groundwater Basin, the Reservoir Lakes Groundwater Basin, and the East Valley Groundwater Basin.

   The groundwater occurs within fill and the Domengine Formation in the Crude Hill Area. This groundwater flows southwest, towards the city of Martinez, which borders the refinery immediately on the southwest and discharges into the Arroyo del Hambre groundwater basin. The flow rates have been estimated to range from 0.34 to 10 feet per year.

   The West Valley Groundwater Basin is located between Middle and Crude Hills. The basin is composed of fill, Bay deposits (sand, mud and peat), Younger Alluvium, Older Alluvium, and the Domengine Formation. The groundwater in this basin discharges in the lower Clayton/Ygnacio Valley groundwater basin and flows generally to the north, towards Carquinez Strait. Groundwater flow velocity has been estimated to range from 0.003 to 82 feet per year.

   The Central Valley Groundwater Basin is located east of Middle Hill and west of the Reservoir lakes Groundwater Basin. Groundwater in this basin discharges into the lower Clayton/Ygnacio Valley groundwater basin and flows to the north, towards Carquinez Strait. The basin is comprised of fill, Bay deposits, Older Alluvium, Domengine and the Meganos Formations. Groundwater flow rates have been estimated at 0.43 to 62 feet per year.

   The Reservoir Lakes Groundwater Basin is located in the central part of the refinery. Groundwater in this basin discharges into the lower CLayton/Ygnacio groundwater basin and generally flows to the north, towards Carquinez Strait. This basin is composed principally of the Meganos Formation with minor occurrences of Domengine Formation along the southwest and Martinez Formation along the northeast edges. Older Alluvium and Bay deposits are also found in the north part of the basin. Groundwater flow velocities have been estimated to range from 0.03 to 2.6 feet per year.

   The East Valley Groundwater Basin is found at the eastern most side of the basin at Vine Hill. This basin is composed of fill, Bay deposits, Younger Alluvium, and the Martinez Formation. Groundwater in this

basin discharges into the lower Clayton/Ygnacio Valley groundwater basin and generally flows north towards Carquinez Strait. Groundwater flow velocity has been estimated to be approximately 0.13 to 5.9 feet per year.

5. A Resource Conservation and Recovery Act (RCRA) Part A Permit Application was submitted to the Environmental Protection Agency (EPA) on November 18, 1980. The Part B Permit Application was submitted on August 1, 1983. This permit application was submitted in an attempt to receive a RCRA permit for the sludge drying beds at the complex. These sludge drying beds have not received any sludge since the permit application was submitted. They are currently used to store excess capacity storm water prior to treatment in the waste water treatment system (referred to as Pond 6, in this Order).

6. Waste discharge requirements were issued on June 23, 1983 in Board Order No. 83-17. These waste discharge requirements were issued for use of the waste water treatment sludge drying beds. Order No. 83-17 did not address other solid waste disposal sites at the refinery.

7. The discharger submitted a site hydrogeologic report on October 25, 1983. This report identified 14 inactive waste disposal areas and numerous petroleum hydrocarbon spill sites at the refinery

8. The California Code of Regulations, Title 23, Chapter 3, Subchapter 15, hereinafter called Subchapter 15, became effective on January 1, 1985. These regulations were written to establish waste and site classifications, and waste management requirements for waste treatment, storage, or disposal of wastes to land in landfills, surface impoundments, waste piles, and land treatment facilities (landfarms).

9. Section 13273 was added to the Porter-Cologne Water Quality Control Act by the legislature in 1984. This Section requires that a Solid Waste Assessment Test, hereinafter called a SWAT, be conducted to establish whether there has been any leakage of hazardous waste from a solid waste disposal facility to soils, the vadose zone or waters of the State.

10. The discharger was identified in the first rank for the SWAT program. They submitted a SWAT report on June 22, 1987. Their report contained limited waste characterization information, site geology, hydrogeology, and land use information, and limited groundwater quality information. The report did not contain sufficient information to determine whether there has been any leakage of hazardous wastes from the solid waste disposal areas, because: 1) the network of groundwater monitoring wells did not provide spatial coverage of the potential groundwater flow paths, and 2) the monitoring program did not contain groundwater samples collected repeatedly over a sufficient time period to determine whether or not there was leakage.

    The report did not contain any vadose zone monitoring information. Site YY is the only site where vadose zone monitoring may be technincally feasible. The need for vadose zone monitoring will be further evaluated in the future.

11. Site Cleanup Requirements, Board Order No. 87-070, were issued by the Board on June 17, 1987. These Site Cleanup Requirements were issued to direct investigation and remedial actions at numerous petroleum hydrocarbon spill sites at the refinery that were identified in the 1983 report.

12. A Report of Waste Discharge, addressing the Waste Water Treatment Pond System, was submitted to the Regional Board on February 9, 1988. This report discussed the physical and chemical characteristics of the surface impoundments, the site geology, climatology, and hydrogeology, and the groundwater monitoring program at the site. The report also discussed the the static and seismic stability of the pond dikes, and the cost of compliance with Subchapter 15 siting and construction standards. The waste water treatment system is an active waste management unit and is subject to the requirements of Subchapter 15. A description of the pond system follows (see Figure 4 for site locations).

    a. The waste water treatment ponds system is comprised of 6 ponds that cover 28 acres in area. The pond system is located in the northwest section of the refinery. The waste water treatment system is used to treat process oily waste, surface water runoff, and other liquid waste streams that originate on the site. The oily waste stream undergoes primary treatment in the American Petroleum Institute (API) separator, where the oil is skimmed form the surface of the water, and solids separate out. Advanced oil and solids removal occurs next in the dissolved air flotation (DAF) unit.

    Secondary treatment occurs in the waste water treatment ponds. Exact construction history is not known. It is believed that fill was placed upon the native soils to form the perimeter dikes. The ROWD states that the fill was probably placed by end dumping. Dike materials typically consist of silty clay with some traces of sand or gravel. It appears that there was little excavation of the site or compaction of the dikes during pond construction. Fill thickness surrounding the pond ranges from 5 to 46 feet. The ponds are unlined. There is no leachate collection and removal system. The site does not provide 5 foot separation of the wastes from groundwater.

    Pond No. 1 receives waste water that has undergone primary treatment. This pond is 1.6 acres in area. The average water depth in the pond is 1 foot, while the average sludge thickness is 5 feet. The pond holds approximately 3.1 million gallons of water. This pond allows flow and constituent equalization prior to pumping to the activated sludge biotreater. Aerators are present in this pond, to aid in mixing, and pH is maintained between 9.5 and 10. This pond has been in service since at least 1921.

    Pond No. 2 is generally used as a temporary holding pond for fluids during high or unusual flows that cannot be handled by Pond No. 1. This pond is 1.2 acres in area. The average water depth in the pond is 1.5 feet, while the average sludge thickness is 4.4 feet. The pond holds approximately 2.2

million gallons of water. This pond has been in service since at least 1921.

Pond No. 3 is used for temporary storage of storm water which is in excess of the capacity of the waste water treatment system. This storm water is then routed through Ponds No. 1 or 2. This pond is 8.1 acres in area. The average water depth is approximately 2.5 feet, while the average sludge thickness is 1.7 feet. The pond holds approximately 15.7 million gallons of water. This pond has been in service since the 1960's.

Pond No. 6 is used for temporary storage of storm water when Pond 3 nears capacity. This storm water is then routed through Ponds No. 1 or 2. This is the largest pond in the system with an area of 13.8 acres. It generally contains no water, and no sludge layer was found during the 1987 investigation of the pond. The pond has a capacity of 26.8 million gallons. This pond has been in service since 1958.

Pond No. 7 is the activated sludge unit or the biotreater. All waste water passes through this pond. The pond is equipped with aerators, to provide oxygen to enhance biological treatment of the wastes. This pond is 1.4 acres in area. The average water depth is 9 feet. Due to constant mixing of the waters in this pond, no sludge accumulation was measured. The pond holds 3.8 million gallons of water. The pond has been in service since the early 1970's. Water is discharged from this pond to the two-stage air flotation clarifiers (above ground tanks).

Pond No. 8 is divided into two sections, one is the sand filter feed pond, and the other is the final holding pond. The sand feed filter pond was used to discharge waters to the sand filters for tertiary treatment. The sand filters are no longer in use, so both sections of the pond act as the final holding pond for waters prior to their NPDES discharge. This pond is 1.5 acres in area. The average depth of water is 4.6 feet, while the average sludge thickness is 1.2 feet. The pond holds approximately 3.2 million gallons of water. This pond has been in service since at least 1921.

During 1987 the waters and the sludges in the waste water treatment ponds were analyzed to determine whether they contained hazardous waste and were subject to the Toxic Pits Cleanup Act (TPCA). Concentration of California Assessment Manual (CAM) metals were generally low in all samples of pond water, and did not exceed hazardous waste criteria. Organic constituents including aniline, benzene, ethylbenzene, 1,3-dimethylbenzene, toluene, xylenes, and phenols were detected in concentrations ranging from 1 to 73 ppm. CAM metals were measured at less than hazardous waste levels in the pond sediments, although 100's of ppm of typical refinery metals (Chromium, nickel, zinc, etc.) were measured. Organic constituents found in the pond sludges included benzene,

ethylbenzene, ethylmethylbenzene, methylcyclohexane, toluene, xylenes, phenolic compounds, napthalenes, phenanthrene, and total hydrocarbons and polynuclear aromatics. These constituents were detected in the 100's and 1000's ppm. Acute aquatic toxicity tests were performed on the water and sludge samples. The toxicity was determined to be greater than 1000 ppm, and as such are considered not to be hazardous waste. The wastes are considered by Regional Board Staff to be designated wastes.

Soils beneath the pond bottoms were sampled and analyzed for waste constituents to determine if migration has occurred. The data indicate that there has been limited impact on soils under the ponds.

Groundwater quality monitoring of 20 wells indicated low levels of waste constituents in both the up- and downgradient wells. Similar waste constituents were found in the up- and downgradient wells except for several volatile and acid/base/neutral extractable organic constituents. It is clear that low levels of waste constituents have been found in the groundwater, it is not clear that these waste constituents have migrated from the pond system or have migrated from somewhere else at the refinery. No statistical analysis of the data have been conducted.

13. A Report of Waste Discharge, addressing 17 inactive waste disposal sites, was submitted on August 3, 1987, with subsequent revisions on February 29, and April 20, 1988. This report provided limited information about waste characteristics, information on site characteristics, some groundwater quality information, a proposal for a general groundwater monitoring plan and conceptual closure plans for each waste site. The report did not contain any information about the solubility, mobility and toxicity of the waste materials at each site. The report did not contain a proposal for a groundwater monitoring program that meets the requirements of Article 5 of Subchapter 15, as the proposed wells are located too far away from the waste management units to immediately detect leakage from those units. Conceptual closure plans submitted for the sites do not meet the requirements of Subchapter 15. Additionally, the waste in many of the waste management units is in contact with the groundwater at the site.

    The following inactive sites are described in the Report of Waste Discharge and are subject to the requirements of Subchapter 15. The site locations are illustrated in Figure 3. The following description of each site includes a brief site history, results of soils investigation at the site, site specific geology and hydrogeology, results of groundwater monitoring at the site, and conclusions regarding the potential impact of the site on the groundwater.

    a. Site K is an inactive oily water sump located located on the east side of Crude Hill. This unit was active in 1916 and was taken out of service in 1960. It was used as a collection area for tank leaks and storm water runoff from the Crude Hill

tank farm. This site is approximately 180 by 170 feet. The waste is believed to be approximately 5 feet thick.

In a 1987 investigation of this unit, 9 soil samples were collected 4 soil borings. The soil samples were analyzed for metals, total organic halogens (TOX), and total petroleum hydrocarbons (TPH). Metals were generally detected at low levels. However, the mean value for manganese in the soils was measured at 437 ppm. The mean value of organic lead equaled the Total Threshold Limit Concentration (TTLC) for a hazardous waste at 13 ppm, while the concentration of total lead in the soils was 68.5 ppm, greater that 10 times the Soluble Threshold Limit Concentration (STLC). The mean value measured for TPH in the soil at the site was 9.3 percent. Ethylbenzene, chlorobenzene, and xylenes were detected in the soils in the only sample that was tested for these compounds. There was no information available regarding the solubility, mobility or toxicity of the waste materials.

A second round of samples were collected in November of 1987, and were analyzed for organic lead. Organic lead was not detected above a detection limit of 1 ppm during this round of sampling.

The site is underlain by up to 20 feet of fill material, which is in turn underlain by the Domengine sandstone. The minimum depth to static groundwater at the site is 2 feet during the wet season, with a seasonal fluctuation of 3 to 8 feet. The groundwater flow in the area is to the north at a velocity estimated to be between 16 and 82 feet per year.

Two groundwater monitoring wells are located downgradient of Site K. Well 28, the closest well to the site has contained a sheen of floating product in the past. Up to 91 ppm of TOC have been measured in this well during 1986. Groundwater from well 172 was analyzed as part of the SWAT program for the site. Manganese, magnesium, and sodium showed increases over background levels as measured in well 54. Carbon tetrachloride, chloroform, 1,2-dichloropropane, and trichloroethene were detected in well 172.

This area is the site of a number of hydrocarbon spills from the tank farm on Crude Hill, and is the site of a former research laboratory which used chlorinated solvents. The petroleum hydrocarbon spill sites are being investigated and remediated pursuant to Board Order No. 87-070.

This inactive site poses a potential threat to water quality because potentially hazardous waste materials are in contact with the groundwater. Although there is no information on the solubility, toxicity and mobility of these waste materials, the levels of TPH, lead, and manganese in the soils are high enough to pose a potential threat to the quality of groundwater at the site. Waste constituents have been detected in the groundwater downgradient of the site.

b. Site I is an inactive land disposal area that was used as a collection area for tank and process drainage and disposal of acid, tetraethyl lead (TEL), asphalt, and tar sludges. The unit was used between 1921 and 1923. A tanker truck filling station currently occupies this area. This site is approximately 1000 by 400 feet. Waste has been detected in borings as deep as 11 feet.

In a 1987 investigation of the soils at Unit I, 10 soil samples were collected for chemical analysis from 6 soil borings. Metals were detected at generally low concentrations (10's of ppm). Some high values (mean value of 2450 ppm) of sulfates were detected in the waste. The mean concentration of TPH at the site was 0.77%. Fifteen of the 18 samples contained concentrations of TPH less than one percent. Benzene, toluene, ethylbenzene, and xylenes, were detected in the 2 samples that were analyzed for these compounds. There was no information available regarding the solubility, mobility or toxicity of the waste materials.

The site is underlain by 5 to 10 feet of fill material, which is in turn underlain by 7 feet of bay mud. Younger alluvium is found at approximately 15 feet thick beneath the bay muds. The Domengine Sandstone is found between 2 and 30 feet below grade.

The minimum depth to static groundwater is approximately 3 feet and seasonal fluctuation has been found to be negligible. Groundwater flow is generally to the north at gradients ranging from 0.010 to 0.040 ft/ft. Hydraulic conductivity of the bay mud at the site has been estimated at approximately 1×10^{-5} to 7×10^{-7} cm/sec. Hydraulic conductivities in the Domengine sandstone have been estimated to be approximately 5×10^{-3} cm/sec.

Groundwater monitoring well 94 has been installed in the waste site. Groundwater quality has been monitored periodically in the past. Hundreds of parts per million of sulfates, and 10's of parts per million TOC have been measured in the well. Groundwater monitoring well 38 is located downgradient and laterally to the site. Between 5 and 120 ppm of TOC have been detected in this well during 1985. Groundwater monitoring well M-5 is located downgradient of the site. This well has detected 100's of ppm sulfates and 10's of ppm TOC. Groundwater monitoring well 179 was monitored as part of the SWAT program for this site. Thousands of ppb of volatile organics, and 10's and 100's of ppb of semi-volatile organics were detected in this well.

Petroleum hydrocarbon spill areas are located up and downgradient of this waste management unit. These spill sites are being investigated and remediated pursuant to Board Order 87-070.

This waste management unit poses a potential threat to water quality because potentially hazardous waste is in contact with the groundwater. There is no information on the solubility, toxicity or mobility of the waste materials, but levels of sulfates and TPH are high enough to pose a potential threat to water quality. Waste constituents have been detected in the groundwater downgradient of the site.

c. Site H is an inactive sludge pond that was used for weathering oily wastes. The site may have received acid and lead sludges as well. The site was active as early as 1921, and some sludges were removed in 1965 prior to installation of Tank 1161 at the site. The site is approximately 2 acres in size. Three quarters of an acre are covered by Tank 1161. The waste was estimated to be 15 feet deep

In a 1987 investigation of the soils in unit H, nine soil samples were collected for chemical analysis from 4 soil borings. The mean value for total lead in the soil samples was 111.9 ppm, greater that 10 times the STLC. Manganese was detected at a mean value of 591 ppm and molybdenum was detected at a mean value of 91.6 ppm. The mean values of sulfate found in the soil was 1654.7 ppm. TPH was detected in the soils at a mean value of 3.1 percent, with 2 of the 6 samples exceeding greater than ten percent (These two soil samples also exhibited high values of sulfate and lead and were collected from below ten feet in depth. Presumably, they correlate to waste materials that were not removed prior to installation of Tank 1161). This site may contain hazardous waste because of the potential to leach hazardous levels of lead from the soil.

The site is underlain by 10 to 12 feet of sandy silt fill, which is underlain locally by 1 to 2 feet of silty clay bay mud. Younger Alluvium is found beneath the bay muds. This sediment is comprised of dense sands and gravels. Domengine sandstone is found between 50 and 75 feet below grade.

Groundwater has been found at approximately 6 feet below grade. Seasonal variations in water level elevation have found to be insignificant. Groundwater flow is generally to the northwest, towards Carquinez Strait, at shallow gradients estimated to be approximately 0.002 ft/ft. Hydraulic conductivities of the fill material at the site have been estimated at approximately 6×10^{-5} cm/sec. Hydraulic conductivities of the sandy bay muds in this area have been estimated to be approximately 4.0×10^{-3} cm/sec.

No groundwater monitoring wells located downgradient of site H have been monitored as part of the quarterly monitoring at the facility. Groundwater monitoring well 175 was monitored as part of the SWAT program for the facility. This well detected 12 ppb bis(2-ethylhexyl)phthalate. The monitoring program at this site is inconclusive, as the program consists of only one

round of water quality data collected from one well.

This waste management unit is located downgradient of petroleum spill sites which are being investigated and remediated pursuant to Board Order 87-070.

This waste management unit poses a potential threat to water quality because potentially hazardous waste is in contact with the groundwater. There is no information on the solubility, toxicity or mobility of the waste materials, although levels of manganese, molybdenum, sulfates and TPH are high enough to pose a potential threat to water quality.

d. Site B is an inactive unit that was used to store tank leaks and overflows. Waste water treatment sludges were stored in unit B for a short period in 1972. There is no other information available on this waste management unit.

e. Site L is an inactive impoundment that was used for the disposal of asphalt pitch from the vacuum re-run area. The site was used from the 1920's to the 1960's. The impoundment was located in a valley behind an earthen berm. The unit is approximately 370 by 350 feet in area and the current height of the embankment is 46 feet. Waste material is found at least 35 feet below grade, and underlying alluvial soils and upper portions of the bedrock are permeated with waste material.

In a 1987 soils investigation, 34 soil samples were collected for chemical analysis from 6 borings. Chemical analysis of these samples indicated that lead was measured at a mean concentration of 83.1 ppm, greater than 10 times the STLC for lead. Organic lead was present in the waste at a mean value of 4.8 ppm. Some samples detected high values of sulfates and sulfides (~2000 ppm). TPH was found at a mean concentration of 4.8 percent, with 13 samples exceeding greater than 10 percent TPH. Ethylbenzene and xylenes were detected in the only sample that was tested for these compounds.

The waste management unit is composed of 35 feet of fill material, which is underlain by 10 feet of stiff clay alluvium. The Domengine Formation is found at a depth of approximately 35 feet.

The minimum depth to static groundwater is approximately 2 feet. Seasonal fluctuations of up to 20 feet have been estimated. Groundwater flow is to the northeast with a gradient ranging from 0.031 to 0.082 ft./ft. Hydraulic conductivities have been estimated to range between 1.4×10^{-2} and 3×10^{-4} cm/sec in the Domengine Formation. Hydraulic conductivities in the alluvium have been estimated from 6×10^{-3} to $<1 \times 10^{-6}$ cm/sec.

A hydrocarbon seep is located downgradient of unit L, at the toe of the site. The seep occurs where the water table

intersects the ground surface. Based on field observations, it is probable that the hydrocarbons are a result of seepage from the unit.

Groundwater quality data were collected from well 103 during 1985 and 1986. Low levels of TOC (10's of ppm) were detected. The monitoring for the SWAT program did not detect EPA Method 624 or 625 compounds, or any apparent increase in metals between the downgradient and background wells.

A static and seismic stability analysis was performed on the waste management unit. Laboratory tests indicated that undrained shear strengths ranged from 1050 to 3000 pounds per square foot (PSF). The stability analysis indicated that the waste management unit was statically stable. Seismic stability analysis was performed assuming a magnitude 6.5 earthquake occurred on the Concord fault, approximately 2.5 miles from the site. Displacement of the waste management unit under an acceleration of 0.65 g was calculated to be 0.1 inch.

This waste management unit poses a potential threat to water quality because potentially hazardous waste is in contact with the groundwater. There is no information on the solubility, toxicity or mobility of the waste materials, however levels of lead, organic lead, and TPH are high enough to impact water quality at the site. The seep downgradient of the unit is evidence that the site is leaking, even though the monitoring well in the vicinity has not detected waste constituents.

f. Site M is located in the north central portion of the refinery and was used for the disposal of coke from 1923 to 1930. This site is now the site of Chemical Areas A and B and the Asphalt Plant. There are two separate parts of the unit, designated Mn (north) and Ms (south).

In a 1987 soil investigation of this unit, 27 soil samples were collected for chemical analysis from 16 borings. Barium was detected at a mean concentration of 508.8 ppm in site Mn, while manganese was found at a mean of 697.2 ppm in site Ms. Two samples in site Ms detected total lead which exceeded 10 times the STLC value for lead. The mean value measured for sulfates was approximately 145 ppm, while sulfides were detected at a mean value of approximately 60 ppm. Generally, less than 1 percent TPH was measured in the soils, except two samples which detected 6 and 35 percent. Ethylbenzene was detected in the one sample that was analyzed for volatile organic compounds. Photoionization detector readings showed elevated (>100 ppm volatile hydrocarbons) readings in many borings drilled at the sites.

Both sites are underlain by approximately 2-10 feet of sandy, silty, clay fill, which is in turn underlain by alluvium or bay mud deposits. The Meganos Formation is found at the base of the sequence.

Groundwater is found at between 2 and 13 feet below ground surface. There is no information available on the seasonal fluctuation of the water table. Groundwater flows generally to the north at hydraulic gradients estimated to be 0.016 ft/ft. Hydraulic conductivity was estimated at approximately 1.3×10^{-6} cm/sec. Groundwater flow velocities were estimated based on a number of wells installed in the area, at between 1.1×10^{-4} to 4.7 ft/day.

Groundwater monitoring well 145 is located directly downgradient of unit Mn. Groundwater quality data collected from this well in 1985 and 1986 detected 10's to 100's parts per million of sulfates and TOC. Benzene was detected at up to 190 ppb, toluene up to 69 ppb, and xylenes up to 54 ppb. Groundwater monitoring well 181 was sampled and analyzed as part of the SWAT program for this unit. This well is generally downgradient of both parts of unit M, however it is not close enough to either unit to be able to definitively conclude whether either of these units are impacting water quality. This well detected 15 to 20 peaks of non-hazardous substances list (HSL) compounds on the chromatogram for EPA Method 625 substances during SWAT monitoring.

This waste management unit is located in the area of a number of petroleum hydrocarbon spills. These spills may be the source of the volatile organics detected in well 145. Groundwater monitoring wells 44 and 147 have detected floating product and the extent of the spill area is being investigated and remediated pursuant to Board Order 87-070.

This waste management unit poses a potential threat to water quality because the waste is in contact with groundwater. There is no information available regarding the solubility, toxicity or mobility of the waste materials, but the levels of barium, manganese and TPH are high enough to impact water quality. Downgradient monitoring wells have detected petroleum hydrocarbon constituents in the groundwater.

g. Site YY was used through the 1950's to dispose of residue from Tanks 8, 9, 10, and 12. There are 4 individual areas which comprise Unit YY. Each are is located next to a tank. These areas are triangular in shape and are less than 200 feet on a side. The waste is approximately 1/2 to 4.5 feet thick.

   In a 1987 soil investigation of this unit, 6 soil samples were collected for chemical analysis from 4 soil borings. In general metallic constituents were detected in low concentrations. Manganese was detected at a mean concentration of 380.8 ppm, and sulfate was measured at a mean concentration of 129.6 ppm. TPH was detected at a mean concentration of 1.0 percent. Surficial soils and upper portions of the sandstone have been impregnated with hydrocarbon residue.

The site is underlain by 15 to 30 feet of older alluvium which is composed of clayey and gravelly sand and sandy gravel. The Meganos Formation is found beneath the older alluvium. The minimum depth to static groundwater is approximately 23 feet, with seasonal fluctuations up to 40 feet. Because this unit is situated on a ridgetop, groundwater flows to the north, east, and west, but ultimately flows to Carquinez Strait. Hydraulic gradients have been estimated to range from 0.14 to 0.17 ft/ft. Hydraulic conductivity of the older alluvium has been estimated to range from 3×10^{-4} to 1×10^{-5} cm/sec, while hydraulic conductivity of the Meganos Formation has been estimated to range from 2×10^{-4} to 9×10^{-7} cm/sec.

These has been no groundwater quality information submitted from wells located close enough to these waste management units to detect whether there has been any impact to the groundwater from those units. Two groundwater monitoring wells were sampled and analyzed as part of the SWAT program for the site, wells 86 and 117. There were no apparent increases in in waste constituents measured in the downgradient well versus background concentrations measured in well 109. EPA Method 624 and 625 compounds were not detected. Vadose zone monitoring was not conducted at this site.

There is no information regarding the solubility, toxicity or mobility of the waste materials. Concentrations of TPH and manganese may have the potential to impact water quality. This site may have a lower potential to impact water quality than some of the other sites, because the waste is situated well above the seasonal high water level. Waste constituents have been found to permeate the upper portions of the sandstone bedrock at the site.

h. Site N is an inactive oily water sump which received oil-water emulsion tank drainings and surface water runoff from 1921 to 1966. This unit was originally constructed as a bermed area in a canyon. Its dimensions are approximately 200 by 130 feet, and it is 28 feet deep. Facility records indicate that sludges or solids were not disposed of in this unit. Some waste materials were removed and clean fill was placed at the surface of the unit prior to construction of the OPCEN area of the refinery.

In a 1987 investigation of this unit, 7 soil samples were collected for chemical analysis from 2 soil borings. Generally low levels of metals were detected in the wastes, except for manganese, which was detected at a mean concentration of 655.4 ppm. Sulfates were detected at a mean concentration of 2517.4 ppm. These waste constituents were detected at the highest concentrations at lower depths in the waste management unit where the residual waste is believed to remain. TPH was generally found at low concentrations averaging 0.4 ppm.

This unit is underlain by up to 28 feet of silty sand and

sandy silt fill, with 8 to 11 feet of probable waste material at the base. The fill is underlain by the Meganos Formation.

Groundwater flow to the north-northwest at a gradient of 0.032 ft./ft. The minimum depth to static groundwater is approximately 18 feet, with seasonal fluctuations of up to 7 feet. Hydraulic conductivities for the fill material have been estimated to be approximately 4×10^{-4} to 2×10^{-6} cm/sec, while permeabilities for the Meganos Formation have been estimated to range from 2×10^{-4} to 8×10^{-6} cm/sec.

Two groundwater monitoring wells are located downgradient of the site, wells 109 and 173. Neither well has been sampled as part of the quarterly groundwater monitoring program at the site. Both wells were sampled as part of the SWAT program. Manganese was detected at 2.2 ppm in well 109 and mercury was detected at 0.0057 ppm in well 173. Both wells detected peaks of 1-5 non-HSL compounds in the EPA Method 625 analysis.

This site poses a potential threat to water quality because potentially hazardous residual waste in this unit may be in contact with the groundwater during the rainy season. Although there is no information regarding the solubility, toxicity or mobility of these waste materials, manganese, sulfides and TPH are present in the waste at concentrations which may impact water quality at the site.

i. Site O is an inactive waste management unit which was used for the disposal of construction debris, refuse, and various waste products such as Tergol clay. The area was also used for drying sludge until 1975. The waste disposal unit is triangular in shape and measures approximately 600 feet on a side. The waste is up to 33 feet deep, and rises 35 feet above the historic ground surface.

In a 1987 soils investigation of this unit, 45 soil samples were collected for chemical analysis from 11 soil borings. Metals were generally detected at low levels except for manganese, which was detected at a mean concentration of 213 ppm. Organic lead was detected in 23 samples. Four samples exceeded hazardous waste criteria for organic lead. Inorganic lead was detected in 40 samples, and it exceeded 10 times the STLC in 13 samples. The mean concentration for inorganic lead was 82.9 ppm, greater than 10 times the STLC for lead. PCB's were detected in 14 samples. The mean concentration of PCB's detected in the waste was 2.66 ppm. The mean concentration of sulfates in the wastes was measured at 2368.5 ppm. TPH was measured at greater than 10 percent in 25 samples. The mean concentration of TPH in the waste was 7.8 percent. Benzene, toluene, ethylbenzene, and xylenes were detected in the waste in the only sample that was analyzed for these compounds.

The waste site consists of 33 feet of waste material and fill which is underlain by approximately 15 feet of stiff, gravelly clay and silt alluvium. The Meganos Formation is found

beneath the waste and fill at depths ranging from 0 to 40 feet below grade.

Groundwater flow is towards the east-northeast at an approximate gradient of 0.021 ft./ft. The minimum depth to static water is approximately 4 feet during the rainy season. Up to 10 feet of fluctuation occurs annually. Hydraulic conductivities of the fill material have been estimated to range from 4×10^{-4} to 2×10^{-6}, and the alluvium ranges from 6×10^{-3} to less than 1×10^{-6} cm/sec.

There are three groundwater monitoring wells located downgradient of Unit O, wells 19, 20 and 85. Up to 148 ppm TOC and up to 330 ppm of sulfates were detected in well 20 during the quarterly monitoring program. Up to 130 ppm TOC and up to 300 ppm sulfates were detected in well 19 during the quarterly monitoring program. Groundwater monitoring well 20 was sampled and analyzed as part of the SWAT program for this unit. Manganese was detected at 1.5 ppm, and 1 to 5 peaks of non-HSL substances were detected in the EPA Method 625 analysis.

A static and seismic stability analysis was performed on the waste management unit. Laboratory tests indicated that undrained shear strengths of the materials ranged from 450 to 4000 pounds per square foot (PSF). The stability analysis indicated that the waste management unit was statically stable. Seismic stability analysis was performed assuming a magnitude 8.0 earthquake occurred on the San Andreas fault 30 miles from the site, or a 6.5 earthquake occurred on the Concord fault, approximately 2.5 miles from the site. Displacement of the waste management unit under an acceleration of between 0.25 and 0.65 g was calculated to range between 0.41 and 3.27 inches.

This waste management unit poses a potential threat to groundwater water quality at the site because potentially hazardous waste is in contact with the groundwater. No information regarding the solubility, toxicity or mobility of the waste material was provided, but levels of manganese, lead, PCB's and TPH are high enough to impact water quality at the site. Additionally, erosion of soils from this unit into Lower Lake Slobodnick (a storm water holding pond) may introduce additional contaminants into this pond, whose outfall is released to Vine Hill Creek as untreated NPDES outfall E-002. Seismic stability of this waste management unit is uncertain.

j. Site Q is an inactive landfill that was used to dispose of oily sludges, such as Tergol clay, from approximately 1940 to 1965. The site is approximately 100 by 250 feet in area. The site is believed to contain only a very thin veneer of waste material. This site is located to the east of Lake Slobodnick and waste material is believed to underlie that storm water

pond.

In a 1987 soils investigation of this unit, 9 soil samples were collected for chemical analysis from 6 soil borings. Metals were generally detected at low levels in the soil samples, except for manganese which was detected at a mean concentration of 447.4 ppm. The mean value for lead was 159.1, which exceeds 10 times the STLC for lead. This concentration was skewed by one of the samples which detected 1308.4 ppm of lead. Sulfates were detected in the waste at a mean value of 751.6 ppm, while TPH was detected in the waste at a mean value of 3.5 percent. Benzene, toluene, ethylbenzene, and xylenes were detected in the waste in the only sample that was analyzed for these compounds.

This site is underlain by 5 to 20 feet of sandy clay and silt, which is believed to be weathered Meganos Formation. The minimum depth to static water is less than 5 feet, with fluctuations of between 2 and 8 feet seasonally. Groundwater flow is to the east at an estimated gradient of 0.118 to 0.190 ft/ft. Hydraulic conductivity was estimated to range from 1.1×10^{-3} to 1×10^{-9} cm/sec.

Two groundwater monitoring wells are located downgradient of this unit, wells 143 and 158. One sample of groundwater collected from well 143 in 1985 measured 160 ppm of sulfates and 96 ppm of TOC. Well 158 has been sampled regularly as part of the quarterly monitoring program at the site and has detected up to 860 ppm sulfates and up to 310 ppm TOC. Groundwater monitoring well 174, which is not located directly downgradient of unit Q was monitored as part of the SWAT program for the site. Manganese and mercury were detected at above background levels measured in well 70. One to 5 peaks of non-HSL compounds were detected in the EPA Method 625 analysis.

This site is located north of the large plume of crude oil resulting from past releases from the large in-ground oil reservoirs in the central part of the refinery. This spill site is being investigated as required by Board Order 87-070.

During February 1986, a slope failure occurred at this unit. Waste materials slumped into Lake Slobodnick. The waste unit was reconfigured to remedy the failure.

A static and seismic stability analysis was performed on the waste management unit. Undrained shear strengths of the materials were estimated at 450 psf, because of the oily nature of the wastes. The stability analysis, performed on the reconfigured unit, indicated that the waste management unit was statically stable. The analysis determined that displacement of the waste would occur if a magnitude 8.0 earthquake occurred on the San Andreas fault 30 miles from the site, or a 6.5 earthquake occurred on the Concord fault, approximately 2.5 miles from the site. Displacement of the

waste management unit under an acceleration of between 0.25 and 0.65 g was calculated to range between 7.3 and 9.1 inches.

This waste management unit poses a potential threat to groundwater water quality at the site because potentially hazardous waste is in contact with the groundwater. There is no information regarding the solubility, toxicity or mobility of the waste constituent, but the levels of manganese, lead, and TPH are high enough to impact water quality at the site. Additionally, erosion of soils from this unit into Lake Slobodnick (a storm water holding pond) may introduce additional contaminants into this pond, whose outfall is released to Vine Hill Creek as untreated NPDES outfall E-002. Static and seismic stability of this unit are uncertain.

k. Site W is an inactive open burning site that was used to burn refuse, and tetraethyl lead and laboratory containers. The ash was disposed of in the site. The waste unit covers approximately 4 acres, is triangular in shape and is approximately 400 feet on a side. The site was used for burning as early as 1938, but burning was halted in the 1950's. The site is currently covered by buildings and parking lots. The site is leased by Genstar Corporation.

In a 1987 soils investigation of the site, 4 composite soil samples were collected for chemical analysis from 4 soil borings. Metals were generally found at low concentrations. Sulfates were found to be somewhat variable in concentration with a mean value of 513.7 ppm. TPH values were variable, with a mean value of 3.5 percent.

Unit W contains up to 26 feet of sandy and clay fill. This fill is underlain by silty alluvial materials, which are in turn underlain by Martinez Formation at depths ranging from 0 to 40 feet. The minimum depth to static groundwater is approximately 10 feet, with up to 9 feet of seasonal fluctuation. Groundwater beneath unit W flows to the east-northeast at an estimated gradient of 0.024 ft/ft. Hydraulic conductivities of the alluvial material have been estimated at 1.1×10^{-3} to less than 1×10^{-6} cm/sec, and 3.7×10^{-3} to 3×10^{-7} cm/sec for the Martinez Formation.

Groundwater monitoring well 177 is located downgradient of Unit W. This well was sampled in July in 1987. Sulfate was detected at 530 ppm, TOC was detected 85 ppm, manganese was detected at 10 ppm, and toluene was detected at 2.1 ppb. This well was also analyzed as part of the SWAT program. Magnesium and calcium were detected at one order of magnitude greater than the upgradient well. Manganese was detected at 3 orders of magnitude greater than upgradient well 80. Sodium was detected at 5 times the concentration of the upgradient well. 1,2-Dichloropropane was detected at 5 ppb, while acetone was detected at 48 ppb. Ten to 15 peaks of non-HSL compounds were detected during the EPA Method 625 analysis.

This waste management unit poses a potential threat to water quality because potentially hazardous waste is in contact with the groundwater. There is no information regarding the solubility, toxicity or mobility of the waste constituents, but levels of sulfate and TPH in the waste are high enough to impact water quality. Magnesium, calcium, and manganese, which are components of the residual ash, have been detected in the groundwater at concentrations which are significantly higher than the background concentrations of these constituents. Many EPA Method 624 and 625 compounds were also detected in the well.

1. Site X is an inactive landfill which was used for disposal of waste water, acid and tetraethyl lead sludges. This unit was active prior to 1964 and was covered with soil in 1976. These acid sludges are less dense than the soil cover and flow to the surface during warm weather. In many places the waste has breached the soil cover that was placed on the site in 1976. The site is located immediately adjacent to Vine Hill Creek, a tributary to Peyton Slough. Water ponds on the site during winter storms. The site is approximately 1700 by 450 feet and covers 11 acres in area. The waste is approximately 10 feet thick.

   In a 1987 investigation of this unit, 34 soil samples were collected for chemical analysis from 19 soil borings. Metals were generally found at low concentrations, however, total lead was measured at a mean concentration of 94.1 ppm, well above 10 times the STLC value for lead. Chlorides were measured at a mean concentration of 2795 ppm, and sulfates were measured at a mean concentration of 2319 ppm. Total organic halogens (TOX) were detected in the waste at a mean concentration of 162.2 ppm, well above concentrations found at any other site at the refinery. TPH was measured at an average concentration of 1.9 ppm, however TPH was found at levels exceeding 10 percent in the northwestern part of the site. Ethylbenzene and xylenes were detected in the three soils samples that were analyzed for volatile organic compounds.

   Additional chemical testing of the waste in October 1987 detected phenolic compounds ranging in concentration from 1800 to 9200 ppb. Acetone, xylene, and various substituted cyclohexanes were also detected.

   This site consists of 2.5 to 22 feet of mixed soil and waste materials. The waste and fill material is placed over approximately 10 to 20 feet of peaty bay mud and younger alluvial sediments. The Martinez Formation crops out in the southeastern portion of the unit and is believed to underlie the unit at an unknown depth.

   The minimum depth to static groundwater is 2 feet, with only minor seasonal fluctuation. Groundwater flows to the north at

an approximate gradient of 0.015 ft/ft. Hydraulic conductivity for the bay mud at the site has been estimated to be approximately 1×10^{-5} to 7×10^{-7} cm/sec. No measurements of the hydraulic conductivity of the alluvial material or the bedrock at this site have been performed.

There are 4 groundwater monitoring wells completed in unit X, 3 are on the downgradient side. These wells are identified as wells 63, 64, 65 and 66. Water quality samples collected from these wells detected metals including barium, chromium, nickel, lead, zinc, and vanadium at the 1 ppm level. Manganese was detected up to 11.6 ppm. Concentrations of sulfates were detected in the groundwater up to 3100 ppm. TOC was measured at concentrations up to 483 ppm. Chlorides were detected up to 19,000 ppm. Water quality data collected for the SWAT program found increases in aluminum, barium, boron, magnesium, potassium, sodium, and vanadium over background concentrations as measaured in well 177. 1-5 peaks of EPA Method 625 non-HSL list compounds were detected in the well.

This waste management unit poses a potential threat to water quality because potentially hazardous waste is in contact with the groundwater. There is no information regarding the solubility, toxicity or mobility of the waste constituents, but levels of lead, sulfate, TOX, TPH, phenolics and other compounds in the waste are high enough to impact water quality. This unit appears to highly susceptible to inundation by floods and has the potential to impact surface water quality.

m. Site Y is an inactive surface impoundment, located in the northeast section of the refinery, that was used from 1950 to 1970 to dispose of tetraethyl lead sludges, caustic sludges, and refuse. The unit is approximately 200 by 400 feet. Waste materials are 16.5 feet thick below the ground surface.

In the 1987 soils investigation of this site 43 soil samples were collected for chemical analysis from 9 soil borings. Copper was detected at a mean concentration of 162.3 ppm, and lead was detected at a mean concentration of 171.2 ppm, well above 10 times the STLC for lead. Manganese was detected at a mean concentration of 205.5 ppm and molybdenum was detected at mean concentration of 106.3 ppm. Sulfates were detected at a mean concentration of 2979.5 ppm and organic lead was detected at a mean concentration of 7.6 ppm. The mean concentration of TPH was 7.1%. Toluene, ethylbenzene, and xylenes were detected in the only sample that was analyzed for these compounds.

Unit Y is composed of sandy clay fill and waste material. It is underlain by clay and clayey sand alluvium of an unknown thickness. The minimum depth to static water at the site is 8 feet, with seasonal fluctuations of up to 4 feet. Groundwater occurs in both the fill and the alluvium and flows to the

north at a very shallow gradient. Hydraulic conductivities for the fill materials have been estimated to range from 4 x 10^{-4} to 2 x 10^{-6} cm/sec, while the hydraulic conductivities for the alluvial materials have been estimated to range from 6 x 10^{-3} to 4 x 10^{-6} cm/sec.

Groundwater monitoring well 148 appears to be completed in the waste unit at the upgradient edge. Quarterly monitoring of this well detected up to 280 ppm sulfates and up to 103 ppm TOC. Groundwater monitoring well 63 is located laterally downgradient of the site and was analyzed as part of the SWAT program for the site. Aluminum, arsenic, boron and sodium were detected above background levels measured in well 148. Benzene, toluene, acetone, butanone, and carbon disulfide were detected up 83 ppb. 2-methylphenol, 4-methylphenol, and 2,4-dimethylphenol were detected up to 82,000 ppb. 15 to 20 peaks of EPA Method 625 non-HSL compounds were detected in this well.

This waste management unit poses a potential threat to water quality at the site because potentially hazardous wastes are in contact with the groundwater. Although there is no information regarding the solubility of the waste materials, concentrations of copper, lead, organic lead, manganese, molybdenum, sulfates, TOX, and TPH are high enough to impact water quality at the site.

n. Site Z'is an inactive landfill that was used to dispose of oily sludges, Tergol clay, Perma-16 filter cake, and calcium sulfonate clays. This unit was put into service in 1968 and became inactive in 1971. Surficial soils were removed in 1983 so tanks T-1256 and T-1257 could be built on the site. The site is approximately 5 acres in area. The tanks cover about one acre each.

In a 1987 soil investigation at the unit, 15 soil samples were collected for chemical analysis from 11 soil borings. In general low levels of metals were detected. Manganese was detected at a mean concentration of 195.6 ppm. Sulfates were detected at a mean concentration of 142.4ppm, while TPH was found at a mean concentration of 1 percent. Only 1 sample detected TPH at greater than 10 percent. Total Organic Halogens (TOX) was detected at a mean concentration of 52.3 ppm.

Unit Z' consists of approximately 10 feet of fill, which is underlain by an unknown thickness of alluvial material. Martinez Formation is found at an unknown depth beneath the alluvial material. The minimum depth to static water at the site is less than 5 feet, with up to 5 feet of seasonal fluctuation. The groundwater flow to the east-northeast at an estimated gradient of 0.005 ft/ft. Hydraulic conductivity of the fill material has been estimated to range from 4 x 10^{-4} to 2 x 10^{-6} cm/sec., and 6 x 10^{-3} to less than 1 x 10^{-6} cm/sec. for the alluvial material.

Groundwater monitoring well 144 is located in the waste management unit, on the downgradient side. Sulfates were detected up to 170 ppm, while TOC was detected up to 211 ppm. Groundwater monitoring well 148 is located laterally to downgradient of unit Z', but has been monitored as a downgradient well. Sulfates were detected up to 310 ppm, while TOC was detected up to 103 ppm. Well 148 was sampled and analyzed as part of the SWAT program for this site. Iron and manganese were detected above background levels measured at well 45. One to 5 peaks of non-HSL EPA Method 625 compounds were also detected.

This waste management unit poses a potential threat to water quality at the site because potentially hazardous wastes are in contact with the groundwater. Although there is no information regarding the solubility of the waste materials, concentrations of sulfates, TOX, and TPH are high enough to impact water quality at the site. These compounds have been detected in well 144.

o. Site AA is an inactive ponds system located on the southeast side of the complex that was used to decant water from catalyst slurry used in catalytic cracking. This unit comprised 6 individual ponds that were used from 1966 to 1974. The unit is approximately 350 by 150 feet in area. Water treatment chemicals were used for precipitation. The sludge was removed form the ponds and ultimately disposed of off site. The residual waste is approximately 4 feet thick. This unit operated with waste discharge requirements issued by the Regional Board.

In a 1987 soils investigation of this unit, 7 samples were collected for chemical analysis from 7 soil borings. Metals were detected at generally low levels, although molybdenum was measured at a mean concentration of 116.7 ppm and manganese was measured at a mean concentration of 486.5 ppm. Total lead was measured at a mean concentration of 186 ppm, greater than 10 times the STLC value for lead. Sulfates were measured at a mean concentration of 1746.3 ppm. TPH was measured at a mean concentration of 1.9 percent, with one sample measuring 8.9 percent. Benzene, toluene, ethylbenzene, and xylenes were detected in one duplicate sample (one out of three samples) from this waste management unit.

The site consists of 10 to 15 feet of of sandy silt and sandy clay fill. This fill is underlain by 15 feet of soft silty clay, bay muds. The bay mud is underlain by 75 feet of alluvial sediments, consisting of alternating layers of sand, silt and clay. The Martinez Formation is found beneath the the alluvial material at an average depth of 60 to 70 feet below grade.

Groundwater is found at a minimum depth of 5 feet, with

approximately 2 feet of seasonal fluctuation. It flows to the north at an approximate gradient of 0.008 ft/ft. Hydraulic conductivity of the bay mud was estimated to range from 4.0 x 10^{-3} to 1 x 10^{-5} cm/sec.

Groundwater monitoring well 90 is located downgradient of the waste management unit. Quarterly monitoring of this well detected manganese up to 30 ppm, sulfates up to 1900 ppm, and TOC up to 365 ppm. Groundwater monitoring well 90 was also samples and analyzed fro the SWAT program at the site. Aluminum, magnesium, calcium, manganese, and sodium were detected well above background levels measured in well 45. Five to 10 non-HSL 625 compounds were also detected.

This site is located adjacent to the Alkalyte spill area that is being investigated pursuant to Board Order No. 87-070.

This site poses a potential threat to water quality because this potentially hazardous waste does not have adequate separation from the groundwater. Although there is little information regarding the solubility, toxicity or mobility of these waste materials, the concentrations are high enough to impact water quality at the site.

p. Site DD is located in the southwestern portion of the refinery. Prior to 1975 the site was used to dispose of oily sludges and tergol clay. It is presently being used to dispose of construction debris. The site is approximately 700 by 800 feet in area.

In a 1987 soil investigation of the site, 59 soil samples were collected for chemical analysis from 21 soil borings. Metals were generally measured at low concentrations, however manganese was measured at a mean concentration of 288.5 ppm, and lead was measured at a mean concentration of 50 ppm, 10 times the STLC value. Organic lead was detected in 13 borings. The average concentration of organic lead in the soil was 1.4 ppm. The mean concentration of sulfate measured in the soil was 362.8 ppm. TOX was detected in 13 borings. The mean concentration was 42.2 ppm. The mean concentration of TPH measured in the soil was 1.5 percent. Toluene, ethylbenzene, and xylenes were detected in the only sample analyzed for these compounds.

The central and western portion of the site is underlain by fill material and recent sediments deposited by the bay and Peyton Slough. This site is then underlain by the Martinez Formation at depths ranging from the ground surface to 45 feet below grade. The minimum depth to static water is approximately 7 feet. There is no information regarding any seasonal fluctuation of the groundwater elevation. Groundwater flow is to the west-southwest at a gradient estimated at 0.024 ft/ft. Soils beneath the unit have an estimated hydraulic conductivity of 5.8 x 10^{-3} cm/sec. The Martinez Formation in the area has a hydraulic conductivity

estimated to be approximately 3.7 x 10^{-3} cm/sec.

Groundwater monitoring well 161 is located in the waste management unit, on the downgradient side. This well was monitored as part of the quarterly monitoring program and also for the SWAT program. Up to 10 ppm manganese, 410 ppm sulfate, and 34 ppm TOC was measured in the well during quarterly monitoring. Iron manganese, sodium and mercury were detected above background concentrations measured in well 74. One to 5 peaks of non-HSL 625 compounds were also detected.

This site poses a potential threat to water quality because potentially hazardous waste are in contact with the groundwater at the site. Levels of lead and manganese are high enough to pose a potential threat to water quality, although the solubility, toxicity or mobility of these waste constituents are not known.

q. The P.G. and E Sludge Terraces are located at the south end of the facility. In 1966, P.G. and E leased property from the discharger to build a facility for drying water treatment and boiler blowdown sludges. The site consists of 3 tiers on approximately 1 acre. The terraces are unlined and contain no system to manage storm water runoff. The terraces became inactive in 1984.

Sampling and analysis of the wastes in 1984 indicated generally low levels of metals in the waste, except for 100's of ppm of barium, copper, and zinc. Soluble levels of copper (2.5 to 14.4 ppm) appear to have the potential to impact water quality. Qualitative analyses for cyanides and sulfides described the concentration of these compounds as "nil." Hydrocarbons were not detected in the percentage ranges in the waste.

On April 23, 1985, the discharger submitted a letter which requested that the sludge drying beds be closed by discing the sludges into the soils and grading the area to prevent ponding of stormwater. On July 26, 1985, the Executive Officer provided conditional approval of the closure plan. This closure plan has not been implemented to date.

A groundwater monitoring well was installed downgradient of the sludge drying beds. Groundwater quality information collected from this well showed traces of metals, and low levels of TOC (10's ppm), but high levels of sulfates (up to 2400 ppm). Sulfates do not appear to be a constituent of the waste, based on a recent chemical analysis of the waste.

The discharger has requested that they proceed with the closure plan, as it was approved in 1985. This closure plan is not consistent with current Subchapter 15 regulations. If the mixture of waste and soil resulting from this closure has the potential to impact water quality, additional protective measures, that are consistent with current

Subchapter 15 regulations, will be required for this unit.

r. The Auxiliary Holding Pond for Tank 1072 is located north of Tank 1072 and west of unit B. This unit was not reported in the refinery's ROWD. It has apparently contained oily wastes in the past. These wastes have been identified by Regional Board Staff in aerial photographs of this unit. There is no information regarding the concentration of waste constituents in the soils in the ponds. There is no groundwater monitoring program for this unit. The unit appears to presently contain storm water runoff.

14. There are 4 surface impoundments at the refinery which are used to manage storm water which is either directly discharged to surface water or is discharged to the waste water treatment system. The waters and the sediment in these ponds were sampled and analyzed as part of the 1987 sampling and analysis program to determine if there were any surface impoundment at the refinery which contained hazardous waste and as such were subject to the TPCA. These surface impoundments are described below and their location is illustrated in Figure 3.

a. Upper Lake Slobodnick is located in the central part of the refinery. This pond contains storm water runoff from process areas and tank farms in the central area of the refinery. The water is treated by the waste water treatment system except under severe storm events when it can be directly discharged if it meets NPDES permit limits for pH, oil and grease, and TOC.

Four samples of water and 2 duplicates were collected from this pond. Cobalt, fluoride, nickel and zinc were detected at less than 1 ppm. Volatile organics were detected at 10's to 100's ppb in 1 out of 4 samples analyzed. Acid/base/neutral extractable organics were detected at 10's of ppb in 2 out of 4 samples that were analyzed.

Pond sludges were described as a black oily substance that detected in all but five sediment survey points at an average thickness of 0.2 feet. Many CAM metals were detected in this sediment including 70 to 90 ppm vanadium, 86 to 140 ppm zinc, and 13 to 41 ppm lead. Volatile organic and acid/base/neutral extractable compounds were detected in the 10's of ppm in the only sample that was analyzed for these compounds.

b. Lower Lake Slobodnick is located directed down stream (north) from upper Lake Slobodnick. This pond contains storm water runoff from the area directly surrounding the pond. Water from this pond is discharged directly to waters of the State after meeting NPDES discharge limits for pH, oil and grease, and TOC.

Chemical analysis of the waters from this pond detected chromium, cobalt, fluoride, nickel, silver, and zinc at generally less than 1 ppm. High levels of volatile organic compounds (10's ppm) were detected in 1 of the 2 samples that

were analyzed for these compounds. Traces of 2 acid/base/neutral extractable organic compounds were detected in 1 out of 2 samples that were analyzed for these compounds.

The northwestern corner of this pond contained a layer of black silty clay which averaged 0.1 foot thick. Many metals were detected in the pond sediments including 20 to 140 ppm vanadium, 47 to 180 ppm zinc, 9 to 43 ppm lead, and 20 to 90 ppm barium. Volatile organic compounds were detected at 10's of ppm.

c. Flare Area Storm Water Holding Pond is located in the southeast portion of the refinery. The pond receives storm water from the eastern portion of the refinery. Water from the pond is directly discharged to waters of the State after meeting NPDES discharge limits for pH, oil and grease, and TOC.

Chemical analysis of waters from the pond detected cobalt, fluoride, lead, nickel, and zinc at less than 1 ppm. Volatile and acid/base/neutral organic compounds were not detected in the one sample that was analyzed for these compounds.

The pond was found not to contain sludge, but only local traces of black, viscous, oily material. This material was not sampled or analyzed. Pond bottom sediments contained 60-80 ppm barium, 59-80 ppm chromium, 14-59 ppm cobalt, 65-80 ppm copper, 140-200 ppm lead, 0.9-2.0 ppm mercury, 78-98 ppm nickel, 70-90 ppm vanadium, and 260-330 ppm zinc. These levels of metals were higher than any other storm water pond. Volatile and acid/base/neutral extractable organic compounds were not detected in the only sample that was analyzed for these compounds.

d. Vine Hill Storm Water Holding Pond is located southeast of the Flare Area Pond and receives storm water from the eastern portion of the refinery. This water is directly discharged to waters of the State after meeting NPDES discharge limits for pH, oil and grease, and TOC.

Chemical analysis of the waters from the pond detected chromium, cobalt, fluoride, nickel, and silver at less than 1 ppm. Total hydrocarbons and xylenes were detected at less than 1 ppm in the only sample that was analyzed for volatile and acid/base/neutral extractable organic compounds.

The pond sediment consists of a brown silty clay overlying a black silty clay. These layers were submitted separated for chemical analysis. Tens of ppm metals were detected in both layers. Leachable concentrations of lead ranged from 0.7 to 3.3 ppm. Volatile and acid/base/neutral organic compounds including parts per million of acetone and xylenes were detected were detected in the only sample that was analyzed for these compounds.

15. A Resource Conservation and Recovery Act (RCRA) Facility

Assessment (RFA) of the Martinez Manufacturing Complex was completed by the Environmental Protection Agency on February 18, 1988. This report identified 52 solid waste management units (SWMU's) in addition to the 16 that have been described above. A number of these SWMU's, although they are not subject to the provisions of Subchapter 15, have the potential to affect water quality at the site. These units are described below and their location is illustrated in Figure 3.

a. The Gross Oil Separator is located in the central area of the refinery. This unit was placed into service in 1966. Process waste water, tank drainage, and first flush surface water runoff from the Light Oil Processing (LOP) and Operations Central (OPCEN) areas are routed to the Gross Oil Separator for preliminary oil, water and solids separation. This separator has a capacity of 44,000 gallons and provides an average settling time of one hour. This unit is constructed of concrete and is below grade. The oil is recycled to the crude unit, while the waste water is routed to the API separator at the head of the waste water treatment system. Solids are removed from the separator annually by vacuum truck.

   This separator is located directly above Lake Slobodnick. During heavy rain events this separator has overflowed and oily waste has discharged to Lake Slobodnick. There is evidence of spills and overflows from this area.

   This site poses a potential threat to water quality because of its below ground construction and the overflows and spills in the past. No soil sampling has been conducted to verify releases from this unit. Groundwater monitoring wells in the area have detected petroleum hydrocarbons floating on the groundwater. It is not known whether these hydrocarbons are a result of spills or overflows from the separator or a result of tank leaks in the area.

b. The Corrugated Plate Interceptor (CPI) is located in the western portion of the refinery and receives process streams from the Operations Central area. The CPI acts as a preliminary oil/water/solids separation unit prior to treatment at the waste water treatment system. The unit was placed into service in 1983. The unit is constructed of concrete and it is below grade. It is divided into two separator bays. Oil is normally recycled to the crude unit, while waste water is routed to waste water treatment system. Solids settle out and are pumped to two bins arranged in series.

   This site poses a potential threat to water quality because of its below grade construction. There is no history of any releases from this unit. However, no soil sampling or groundwater monitoring has been conducted at the site.

c. The API separator is located in the northwest corner of

the facility and is the main component of the facility's waste water treatment system. Approximately, one-third of all waste water generated at the refinery is oily waste and is routed through the API Separator. The remaining two-thirds of the waste water is essentially oil-free and is generated from process areas, boiler blowdown, and cooling water blowdown.

The unit is below grade, and is 45 by 18 feet, and 6 feet deep. It is constructed of concrete. Total design capacity of the unit is 7500 gallons per minute. This unit provides oil/water/solids separation after similar treatment of the waste water through the Gross Oil Separator. This unit was placed into service in 1962. This unit poses a potential to threat groundwater quality because of its below ground construction. There is no history of any groundwater releases from this unit. However, no soil sampling or groundwater monitoring has been conducted at this unit.

d. The Flash Mixer/pH Adjustment Unit is located in the northwest corner of the refinery adjacent to the API Separator. There are two flash mix tanks with a capacity of 6000 gallons, and a floc growth tank with a capacity of 24,000 gallons. Both units are constructed of concrete and are below grade. Caustics are added to the flash mix tanks to precipitate out calcium and magnesium. The floc (essentially oil droplets and suspended solids) that forms in the floc growth tank enhances the operation of the DAF. These units were placed into service in 1962. This unit poses a potential threat to groundwater quality of of its below ground construction. There is no history of any groundwater releases from these units. However, no soil sampling or groundwater monitoring has been conducted.

e. The DAF units are located in the northwestern portion of the refinery near the API Separator. The DAF units are composed of two subgrade concrete tanks with a capacity of 113,000 gallons each. Normal dry weather flow through the unit averages 3000 gpm and wet weather flow averages 5000 gpm. Waste water from the floc growth tank is mixed with clarified recycle water which has been pressurized with air to 50 to 60 psig. Floc particles attach themselves to the air bubbles and form a floc blanket on the surface. This oily floc is incinerated. These units were placed into service in 1962. These units poses a potential threat to groundwater quality because of there below ground construction. There is no history of any groundwater releases from these units. However, no soil sampling or groundwater monitoring has been conducted.

f. The final pH adjustment unit is located in the northwest portion of the facility adjacent to the biotreater equalization ponds. This unit is a subgrade concrete tank where sulfuric acid is added to the waste water to lower pH of the influent to the ponds to approximately 9.0. This pH adjustment is necessary to meet NPDES permit limits. The date

of startup of this unit is unknown. This unit poses a potential threat to groundwater quality because of its below ground construction. There is no history of any releases to groundwater from this unit. However, there has been no soil sampling or groundwater monitoring at the site.

g. The Caustic Sump is located in the south central portion of the refinery. This subgrade concrete sump collects hydrocarbon-free caustics from the sulfide caustic flash pot and the knock out pot. The contents of the sump are then pumped to an above ground tank prior to treatment. The dimensions of the sump are unknown. The sump was placed into service in 1966. This unit poses a potential threat to groundwater quality because of its below grade construction. There is no history of releases to groundwater from this unit. However, soil sampling or groundwater monitoring has not been conducted.

h. The Inactive Oil Collection Tanks and Sumps are located adjacent to inactive landfill L. This area was used in very early refinery operations, and the exact operation of the system is unknown. This unit consists of two below grade concrete tanks, a concrete sump, an unlined sump and a concrete overflow channel that connects both tanks. Soil staining was apparent at the time of an inspection of this unit. No investigation of releases to soil or groundwater have been performed.

i. Product Loading areas exist throughout the refinery. There is a potential threat to groundwater quality from spills which occur at product loading facilities. There is no documentation of spills or releases from these units. However, there has been no investigation of these units. There are no tank car cleaning or truck washing areas at the refinery.

16. All of the waste management units listed in this Order are subject to this Order.

17. Section 13227 of the Water Code requires the Board to review closure plans submitted pursuant to Section 25246 of the Health and Safety Code for hazardous waste facilities in order to assure adequate protection of water quality. The Board may condition its approval of these closure plans. Regulations contained in Title 22, California Code of Regulations which implement the Health and Safety Code, set a closure standard (Section 67211, Title 22) that includes minimization of migration of waste constituents to State waters. The Board finds that substantial compliance with the siting and construction standards contained in Subchapter 15 of Title 23 constitutes adequate minimization of waste migration for sites being closed.

18. The Board adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) on December 17, 1986. This Order implements the water quality objectives stated in the Basin Plan.

19. The beneficial uses of Carquinez Strait in the vicinity of the site are:

    a. Industrial service supply
    b. Navigation
    c. Contact and non-contact water recreation
    d. Commercial and sport fishing
    e. Wildlife and estuarine habitat
    f. Preservation of rare and endangered species
    g. Fish migration and spawning
    h. Shellfish harvesting

20. a. The potential beneficial uses of groundwater in the vicinity of the site include:

        1) Industrial process water and service supply
        2) Agricultural supply
        3) Municipal and Domestic Supply

    b. However, the shallow groundwater is generally discharged to Carquinez Strait.

21. The action to issue waste discharge requirements for continued operation of existing waste management units and for closure of waste management units is exempt from the California Environmental Quality Act (Public Resources Section 2100 et. seq.) in accordance with Section 15301 of the California Administrative Code.

22. The Board notified the discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for the discharge and has provided them with an opportunity for a public hearing and an opportunity to submit their written views and recommendations.

23. The Board, in a public hearing held on September 21, 1988, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, that the discharger and any other persons that own the land or operate these units shall meet the applicable provisions contained in Division 7 of the California Water Code and regulations adopted thereunder and shall comply with the following (unless otherwise noted, any references to Sections and Articles refer to Subchapter 15 of Title 23):

A. Prohibitions

1. The discharge, storage, or treatment of waste, or materials which may impact the beneficial uses of the ground and surface water, shall not be allowed to create a condition of pollution or nuisance as defined in Sections 13050 (l) and (m), respectively, of the California Water Code.

2. Significant migration of pollutants through subsurface transport to waters of the State is prohibited.

3. There shall be no discharges of wastes to surface waters except as permitted under the National Pollutant Discharge Elimination System.

B. Specifications

The following specifications apply as set forth in the provisions.

1. General Specifications

a. During waste disposal, handling, or treatment, no wastes shall be placed in a position where they can be carried into waters of the State.

b. The containment structures for the units shall have a foundation or base capable of providing support for the structures and capable of withstanding hydraulic pressure gradients to prevent failure due to settlement, compression, or uplift.

c. The units shall be operated to ensure that wastes will be a minimum of 5 feet above the highest anticipated elevation of underlying groundwater.

d. The units shall prevent migration of wastes to adjacent geologic materials, groundwater, or surface water, throughout the operation, closure, and post-closure periods.

e. The containment structures shall be designed by, and constructed directly under the supervision of and certified by, a registered civil engineer or a certified engineering geologist. The discharger shall receive written approval of the construction by the Executive Officer before use of the facility commences.

f. The materials used for containment structures shall have appropriate chemical and physical properties to ensure containment of wastes at all times. Liner permeabilities shall be determined relative to the fluids, including waste and leachate, to be contained. Permeabilities specified for final cover shall be relative to water. Liner permeabilities shall be determined by appropriate field test methods in accordance with accepted civil engineering practice.

g. Earthen materials used in containment structures shall meet the specifications given in Section 2541 (d).

h. The units shall be designed to withstand the maximum credible earthquake without damage to the foundation or to the structures which control leachate, surface drainage, erosion, or gas.

i. The integrity of containment structures shall be maintained at all times.

2. Class I Siting Specifications

a. Class I disposal units shall be located where natural geologic features provide optimum conditions for isolation of wastes from waters of the State.

b. Class I disposal units shall be immediately underlain by natural geologic materials which have a permeability (primary and secondary) of not more than 1×10^{-7} cm/sec, and which are of sufficient thickness to prevent vertical movement of fluid, including waste and leachate, from the unit to waters of the state for as long as the wastes pose a threat to water quality.

c. Class I disposal units shall have natural or artificial barriers to be used to prevent lateral movement of waste, leachate, and fluids.

d. Class I disposal units, other than land treatment units, shall be located outside of floodplains subject to inundation by floods with a 100-year return period, unless such units are designed, constructed, operated, and maintained to prevent inundation or washout due to floods of the 100 year return period.

e. Class I disposal units, other than land treatment units, shall have a 200-foot set back from any known Holocene fault. Existing II-1 and treatment and storage units may be located within 200 feet of a known Holocene fault, provided that containment structures are capable of withstanding ground accelerations associated with the maximum credible earthquake.

f. Class I disposal units, other than land treatment units, shall

be located outside areas of potential rapid geologic change, unless containment structures are designed, constructed, operated, and maintained to preclude failure, as a result of such changes.

g. Class I disposal units shall be located outside areas subject to tsunamis, seiches, and surges, unless they are designed, constructed, operated, and maintained to preclude failure due to such events.

3. Class II Siting Specifications

a. Class II disposal units shall be located where site characteristics and containment structures isolate wastes from the waters of the State.

b. Class II disposal units shall be immediately underlain by natural geologic materials which have a permeability (primary and secondary) of not more than 1×10^{-6} cm/sec, and which are of sufficient thickness to prevent vertical movement of fluid, including waste and leachate, from the unit to waters of the state for as long as the wastes pose a threat to water quality.

c. Class II disposal units shall have natural or artificial barriers to be used to prevent lateral movement of waste, leachate, and fluids.

d. Class II disposal units shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods of the 100 year return period.

e. Class II disposal units, other than land treatment units and expansions of existing Class II units, shall have a 200-foot set back from any known Holocene fault. Existing II-1 and treatment and storage units may be located within 200 feet of a known Holocene fault, provided that containment structures are capable of withstanding ground accelerations associated with the maximum credible earthquake.

f. Class II disposal units shall be designed, constructed, operated, and maintained to preclude failure, as a result of rapid geologic change.

g. Class II disposal units may be located in areas subject to tsunamis, seiches, and surges, providing they are designed, constructed, operated, and maintained to preclude failure due to such events.

4. Class I Construction Specifications

a. Class I waste management units shall comply with Construction Standards pursuant to Article 4.

b. Class I landfills, surface impoundments, and waste piles must have a liner which meets the requirements of Section 2542. A clay liner, a minimum of 2 feet thick shall be installed at a relative compaction of at least 90 percent. A synthetic liner shall be at least 40 mils where used in combination with a clay liner. Liners shall cover all natural geologic material at the waste management unit likely to come into contact with waste or leachate.

c. Class I landfills, surface impoundments, and waste piles shall install a leachate collection and removal system which meets the requirements of Section 2543. The system shall be installed directly above underlying containment features for landfills, or between the inner and outer liner. It shall be designed, constructed, maintained, and operated to collect twice the maximum anticipated daily volume of leachate from the waste management unit.

d. Class I disposal units shall be fitted with subsurface barriers meeting the specifications contained in Section 2545. These subsurface barriers shall be used in conjunction with natural geologic material to prevent lateral movement of fluid, including waste and leachate.

e. Class I disposal units shall have precipitation and drainage control facilities meeting the applicable specifications contained in Section 2546. These facilities shall be designed and operated to accommodate the probable maximum precipitation.

5. Class II Construction Specifications

a. Class II waste management units shall comply with Construction Standards pursuant to Article 4.

b. Class II landfills, surface impoundments, and waste piles must have a liner which meets the requirements of Section 2542. A clay liner, a minimum of 2 feet thick shall be installed at a relative compaction of at least 90 percent. A synthetic liner shall be at least 40 mils where used in combination with a clay liner. Liners shall cover all natural geologic material at the waste management unit likely to come into contact with waste or leachate.

c. Class II landfills and surface impoundments shall install a leachate collection and removal system which meets the requirements of Section 2543. The system shall be installed directly above underlying containment features for landfills, or between the inner and outer liner. It shall be designed,

constructed, maintained, and operated to collect twice the maximum anticipated daily volume of leachate from the waste management unit.

d. Class II disposal units shall be fitted with subsurface barriers meeting the specifications contained in Section 2545. These subsurface barriers shall be used in conjunction with natural geologic material to prevent lateral movement of fluid, including waste and leachate.

e. Class II disposal units shall have precipitation and drainage control facilities meeting the applicable specifications contained in Section 2546. These facilities shall be designed and operated to accommodate the probable maximum precipitation.

6. General Closure Specifications

a. Closure of all waste management units shall be in compliance with the requirements of Article 8.

b. Classified waste management units shall be closed according to an approved closure and post-closure maintenance plan which provides for continued compliance with the applicable standards for waste containment and precipitation and drainage controls in Article 4 and the monitoring program requirements in Article 5.

c. The post closure maintenance period shall extend as long as the wastes pose a threat to water quality.

d. Closure shall be under the direct supervision of a registered civil engineer or a certified engineering geologist.

e. Closed waste management units shall be provided with at least two permanent monuments installed by a licensed land surveyor or a registered civil engineer, from which the location and elevation of wastes, containment structures, and monitoring facilities can be determined throughout the post-closure maintenance period.

f. Vegetation for closed waste management units shall be selected to require minimum irrigation and maintenance, and shall not impair the integrity of containment structures including the final cover.

7. Landfill Closure Specifications

a. Closed landfills shall be provided with not less than two feet of appropriate materials as a foundation layer for the final cover. The foundation layer shall be compacted to the maximum density obtainable at optimum moisture content using methods that are in accordance with accepted civil

engineering practice.

b. Closed landfills shall be provided with not less than one foot of soil containing no waste or leachate, placed on top of the foundation layer equal to permeability of any bottom liner system, underlying natural geologic materials or 1 x 10^{-6} cm/sec, whichever is less.

c. Closed landfills shall be provided with not less than one foot of soil containing no waste or leachate, placed on top of the material described in Specification 7.b; the rooting depth of any vegetation planted on the cover shall not exceed the depth to the material in Specification 5.b.

d. Closed landfills shall be graded and maintained to prevent ponding and to provide slopes of at least three percent. Lesser slopes may be allowed if any effective system is provided for diverting surface drainage from covered wastes. Areas with slopes greater than 10 percent, surface drainage courses, and areas subject to erosion by water and wind shall be protected or designed and constructed to prevent such erosion.

e. Throughout the post-closure maintenance period, the discharger shall maintain the structural integrity and effectiveness of all containment structures, and maintain the final cover as necessary to correct the effects of settlement or other adverse factors; continue to operate the leachate collection and removal system as long as leachate is generated and detected; maintain monitoring systems and monitor the groundwater, surface water, and the unsaturated zone in accordance with applicable requirements of Article 5 of this subchapter, prevent erosion and related damage of the final cover due to drainage and protect and maintain surveyed monuments.

8. Surface Impoundment Closure Specifications

a. For Class II surface impoundments, all free liquid remaining in a surface impoundment at the time of closure shall be removed and discharged at an approved waste management unit. All residual solids shall be treated to eliminate free liquid.

b. For Class II surface impoundments, following the removal and treatment of liquid waste, the impoundment shall be closed in one of two ways, as approved by the Board:

1. All residual wastes, including sludges, precipitates, settled solids, and liner materials contaminated by wastes, shall be completely removed from the impoundment and discharged to an approved waste management unit. Remaining containment features shall be inspected for contamination and, if not contaminated, may be

dismantled. Any natural geologic materials beneath or adjacent to the closed surface impoundment that have been contaminated shall be removed for disposal at an appropriate waste management unit. If, after reasonable attempts to remove such contaminated materials, the discharger demonstrates that removal of all remaining contamination is infeasible, the waste management unit shall be closed as a landfill pursuant to Section 2581 of Article 8.

2. All residual wastes, including sludges, precipitates, settled solids, and liner materials, shall be compacted, and the waste management unit shall be closed as a landfill pursuant to Section 2581 of Article 8, provided that the closed waste management unit meets applicable standards for landfill waste management units in Articles 3 and 4. The moisture content of the residual wastes, including sludges, shall not exceed the moisture-holding capacity of the waste either before or after closure. Surface impoundments which contain only decomposable wastes at closure may be closed as land treatment facilities according to Section 2584 of Article 8.

c. For Class I surface impoundments remove all liquid wastes. Following removal and proper disposal of liquid wastes, all residual wastes and contaminated liners and soils shall be removed or it shall be demonstrated by the discharger that removal is not feasible. If wastes, contaminated liners or soils, are left in place the surface impoundment shall be closed in a manner that minimizes the potential for migration of waste constituents, their degradation products, or leachate to State waters. Compliance with Articles 3 and 4 of Subchapter 15 to the extent feasible and necessary shall be deemed adequate containment for minimization of potential migration. Engineered alternatives that provide equivalent protection of water quality may be used as substitutes for requirements contained in Articles 3 and 4.

9. Groundwater Monitoring Specifications

a. A groundwater quality monitoring program which is capable of detecting leaks from waste management units into waters of the state, during the active life, the closure and post-closure monitoring periods shall be implemented. This program shall comply with all applicable sections of Article 5.

b. Water quality protection standards will be established by the Board according to the conditions outlined in Section 2552. These standards shall be generated upon submittal of an approved groundwater quality monitoring program and based upon one year of background groundwater quality monitoring data collected at each waste management unit.

c. Points of compliance will be established by the Board according to Section 2553 upon submittal of an approved groundwater quality monitoring program.

d. The compliance period for groundwater monitoring shall extend until the waste no longer poses a threat to water quality.

e. The design and construction of the groundwater monitoring system shall comply with the specifications outlined in Section 2555(b) through (d) of Article 5.

f. The groundwater sampling and analysis program shall ensure that groundwater quality data are representative of the groundwater in the area of the waste management unit and comply with Section 2555 (e) through (g) of Article 5.

g. Statistical procedures as outlined in Section 2555 (h) shall be used to determine whether the water quality protection standards have been exceeded at any unit.

h. A detection monitoring program, as required in Section 2556, shall be implemented at each waste management unit, or group of contiguous waste management units.

i. A verification monitoring program, as required in Section 2556 and 2557, shall be implemented upon the determination that a statistically significant increase in indicator parameters or waste constituents has occurred during detection monitoring at a waste management unit or group of units.

j. A corrective action program, as required in Section 2557 and 2558, shall be implemented upon completion of the verification monitoring program.

k. Unsaturated zone monitoring, as required in Section 2559, shall be conducted where feasible.

10. Specifications for Exemptions to the Requirements of Subchapter 15

a. The discharger may request the Board to grant exemptions to the construction or prescriptive standards of Subchapter 15 if both the following conditions are met: (1) the construction or prescriptive standard is not feasible because it is unreasonably burdensome and will cost substantially more than alternatives, or is impractical and will not promote attainment of applicable performance standards; and (2) there is a specific engineered alternative that is consistent with the performance goal addressed by the particular construction or prescriptive standards, and affords equivalent protection against water quality impairment.

11. Specifications for Inactive Waste Management Units

a. A groundwater monitoring program must be developed and implemented at each inactive waste management unit in accordance with Article 5.

b. A corrective action program must be developed and implemented at each inactive waste management unit. The corrective action program shall take into account the results of the groundwater monitoring program for the site. If the corrective action program proposes to leave wastes in place, the program shall implement the applicable closure provisions of Subchapter 15 to the extent feasible and necessary. For corrective action at surface impoundments that contain hazardous wastes where the corrective action program proposes to leave the wastes in place, the program shall implement Specification B.8.c

C. Provisions

1. The discharger shall comply with Prohibitions A.1 through A.3 immediately upon adoption of this Order.

2. The discharger shall comply with Specification B.9 and Article 5 according to the following tasks and time schedule:

   a. Submit a proposal for a refinery wide groundwater monitoring program.
   REPORT DUE: 10/31/88

   b. Submit an investigation sampling plan and a quality assurance/quality control plan which will be followed for all site investigations at the refinery.
   REPORT DUE: 12/31/88

   c. Achieve full compliance according to the groundwater monitoring plan as approved by the Executive Officer
   COMPLIANCE DATE: 12/31/89

   d. If it is determined by the Executive Officer, based on information generated from Provision 2.c, that water quality impairment has occurred, and that this water quality impairment has not originated from a waste management unit that is cited in this Order, or a spill site that is covered as part of Board Order 87-077, the discharger shall submit a groundwater corrective action plan.
   REPORT DUE: according to a date specified by the Executive Officer

3. WASTE WATER TREATMENT PONDS

   The discharger shall comply with Specification B.9 according to the following tasks and time schedule:

   a. Achieve full compliance with Specification B.9 according to the groundwater monitoring plan as approved by the Executive Officer.
   COMPLIANCE DATE: 12/31/89

4. INACTIVE ACCESSIBLE SUBCHAPTER 15 SITES (K, L, O, Q, X, Y, AA, DD, YY)

   The Discharger shall comply with Specifications B.9 and B.11 according to the following tasks and the time schedule found in Appendix 1.

   a. Submit a waste characterization plan. This plan shall be capable of determining the concentrations of soluble waste constituents in each of the waste sites, the potential

mobility of each of the wastes, and the toxicity of the waste materials and the leachable constituents.
REPORT DUE: as per Appendix 1

b. Submit the waste characterization report.
REPORT DUE: as per Appendix 1

c. Submit a site specific groundwater monitoring plan in accordance with Specification B.9 and Article 5. This plan must meet all of the requirements for a complete SWAT program.
REPORT DUE: as per Appendix 1

d. Achieve full compliance with Specification B.9 and the SWAT program according to the groundwater monitoring plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

e. Submit a corrective action proposal in accordance with Specification B.11. At the discretion of the Executive Officer, this plan shall include a detailed discussion and the cost and consequences of the following corrective action strategies: 1) clean closure of the site; 2) full compliance with Subchapter 15 regulations; 3) engineered alternatives that are consistent with the closure and corrective action requirements of Subchapter 15; 4) recycle alternatives; 5) treatment methods for residual waste constituents; and 6) no action.
REPORT DUE: as per Appendix 1

f. Achieve full compliance with Specification B.11 according to the corrective action plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

5. INACTIVE SUBCHAPTER 15 SITES THAT ARE COVERED BY STRUCTURES (I, H, M, N, W, Z')

The Discharger shall comply with Specifications B.9 and B.11 according to the following tasks and the time schedule found in Appendix 1.

a. Submit a waste characterization plan. This plan shall be capable of determining the concentrations of soluble waste constituents in each of the waste sites, the potential mobility of each of the wastes, and the toxicity of the waste materials and the leachable constituents.
REPORT DUE: as per Appendix 1

b. Submit the waste characterization report.
REPORT DUE: as per Appendix 1

c. Submit a site specific groundwater monitoring plan in accordance with Specification B.9 and Article 5. This plan

must meet all of the requirements for the SWAT program.
REPORT DUE: as per Appendix 1

d. Achieve full compliance with Specification B.9 and the SWAT program according to the groundwater monitoring plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

e. If it is determined based on the information generated for Provision 5.b and d, that waste constituents are being released to groundwater from any of these units, the discharger shall define the extent of the waste constituents in the soil and groundwater and submit a proposal for corrective action. The proposal shall be in accordance with Specification B.11 and shall include a detailed discussion of at least three clean-up or containment strategies and the estimated cost and consequences of each one. The plan shall describe the actions that will be taken to prevent future releases from the unit(s).
REPORT DUE: as per Appendix 1

f. Achieve full compliance with Specification B.11 according to the corrective action plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

6. INACTIVE SUBCHAPTER 15 SITES (B, AUXILIARY HOLDING POND FOR TANK 1072,)

The discharger shall comply with Specifications B.9 and B.11 according to the following tasks and time schedules:

a. Submit a proposal for a Report of Waste Discharge.
REPORT DUE: as per Appendix 1

b. Submit the Report of Waste Discharge according to the proposal as approved by the Executive Officer.
REPORT DUE: as per Appendix 1

c. Submit a site specific groundwater monitoring plan in accordance with Specification B.9 and Article 5. This plan must meet all of the requirements for the SWAT program.
REPORT DUE: as per Appendix 1

d. Achieve full compliance with Specification B.9 and the SWAT program according to the site specific groundwater monitoring plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

e. Submit a corrective action proposal in accordance with Specification B.11. At the discretion of the Executive Officer, this plan shall include a detailed discussion and the cost and consequences of the following corrective

action strategies: 1) clean closure of the site; 2) full compliance with Subchapter 15 regulations; 3) engineered alternatives that are consistent with the closure and corrective action requirements of Subchapter 15; 4) recycle alternatives; 5) treatment methods for residual waste constituents; and 6) no action.
REPORT DUE: as per Appendix 1

f. Achieve full compliance with Specification B.11 according to the corrective action plan as approved by the Executive Officer.
COMPLIANCE DATE: as per Appendix 1

7. P. G. AND E. SLUDGE TERRACES

The discharger shall comply with Specification B.9 and B.11 according to the following tasks and time schedules:

a. Submit a site specific groundwater monitoring plan in accordance with Specification B.9 and Article 5. This plan must meet all of the requirements for the SWAT program.
REPORT DUE: 10/31/88

b. Achieve full compliance with Specification B.9 and the SWAT program according to the site specific groundwater monitoring plan as approved by the Executive Officer.
COMPLIANCE DATE: 12/31/89

c. Close the waste management unit according to the closure plan submitted April 23, 1985, and conditionally approved by the Executive Officer on July 26, 1985.
COMPLIANCE DATE: 10/31/88

d. Submit plan for analysis of representative samples of the waste/soil mixture to determine whether the site has the potential to impact water quality in proposed closure configuration.
REPORT DUE: 11/30/88

e. Submit analysis of representative samples of waste/soil mixture.
REPORT DUE: 1/31/89

f. If the waste/soil mixture is found to have the potential to impact water quality, submit an amended closure/corrective action plan in compliance with Specification B.11.
REPORT DUE: 3/31/89

g. Achieve compliance with the closure/corrective action plan as approved by the Executive Officer.
COMPLIANCE DATE: 9 months after the determination

8. RCRA FACILITY ASSESSMENT/INVESTIGATION SITES

The discharger shall investigate the potential for groundwater pollution from these units according to the following tasks and time schedules:

a. Submit a proposal and time schedule for a site investigation to determine whether there are any discharges of waste constituents from the units to groundwater.
REPORT DUE: 1/31/90

b. Submit the site investigation report in accordance with the proposal and time schedule submitted for Provision 7.a as approved by the Executive Officer.
REPORT DUE: 1/31/91

c. If it is determined based on the information generated for Provision 7.b, that waste constituents are being released to groundwater from any of these units, the discharger shall define the extent of the waste constituents in the soil and groundwater and submit a proposal for corrective action. The proposal shall include a detailed discussion of at least three clean-up or containment strategies and the estimated cost and consequences of each one. The alternatives must range from removal of all waste constituents to no action. Additionally, the discharger shall submit plans to prevent future releases from the unit(s).
REPORT DUE: 9 months after the determination.

9. If the Discharger is delayed, interrupted or prevented from meeting one or more of the completion dates specified in this Order, the discharger shall promptly notify the Executive Officer.

10. All soil and groundwater and soil samples shall be analyzed by State certified laboratories, or laboratories accepted by the Executive Officer using approved EPA methods for the type of analyses to be performed. All laboratories shall maintain quality assurance/quality control records for the Board staff review.

11. The discharger shall maintain in good working order, and operate, as efficiently as possible, any facility or control system installed to achieve compliance with the requirements of this Order.

12. The discharger shall permit the Board, or its authorized representative, in accordance with Section 13267(c) of the California Water Code:

a. Entry upon premises in which any pollution sources exist, or may potentially exist, or in which any required records are kept, which may be relevant to the Order. Such access shall be accomplished in accordance with written Shell health and safety, environmental, and quality assurrance policies and procedures.

b. Access to copy any records required to be kept under the terms and conditions of this Order.

c. Inspection of any monitoring equipment of methodology implemented in response to this Order.

d. Sampling of any groundwater or soil which is accessible, or may become accessible, as part of any investigation or remedial action program undertaken by the Discharger.

13. The discharger shall remove and relocate any wastes which are discharged at this site in violation of these requirements or an approved closure or remediation plan.

14. The discharger shall file with this Board a report of any material change or proposed change in the character, location, or quantity of this waste discharge. For the purpose of these requirements, this includes any proposed change in the boundaries, contours, or ownership of the disposal areas.

15. The discharger shall notify the Board if during any subsurface investigations conducted on the refinery property soil contamination is identified which may potentially have an adverse impact on ground or surface waters.

16. If the discharger has commenced work under a program or plan approved by the Executive Officer and is in compliance with the schedule of work under that program or plan, then the discharger shall be deemed to be in full compliance with the program or plan even though all of the work or tasks to ultimately be performed have not been completed.

17. This discharger shall maintain a copy of this Order at this site so as to be available at all times to site operating personnel.

18. The Board considers the property owner and site operator to have a continuing responsibility for correcting any problems within their reasonable control which arise in the future as a result of this waste discharge or water applied to this property during subsequent use of the land for other purposes.

19. These requirements do not authorize the commission of any act causing injury to the property of another or of the public, do not convey any property rights, do not remove liability under federal, state or local laws, and do not authorize the discharge of waste without the appropriate federal, state, or local permits, authorizations, or determinations.

20. If the discharger is delayed, interrupted or prevented from meeting one or more of the time schedules in this Order due to circumstances beyond their reasonable control, the discharger shall promptly notify the Executive Officer. In the event of such delays, the Board will consider modification of the time schedules established in this Order.

21. This Order supersedes Order No. 83-17. Order No. 83-17 is hereby rescinded.

I, Steven R. Ritchie, Executive Officer, do hereby certify the foregoing is a full, true and correct copy of an Order of the California Regional Water Quality Control Board, San Francisco Bay Region, on September 21, 1988.

STEVEN R. RITCHIE
Executive Officer

Attachments:

Figure 1- Site Map
Figure 2- Groundwater Basins
Figure 3- Waste Management Unit Locations
Figure 4- Waste Water Treatment Pond System

Appendix 1- Time Schedule for Compliance with Order

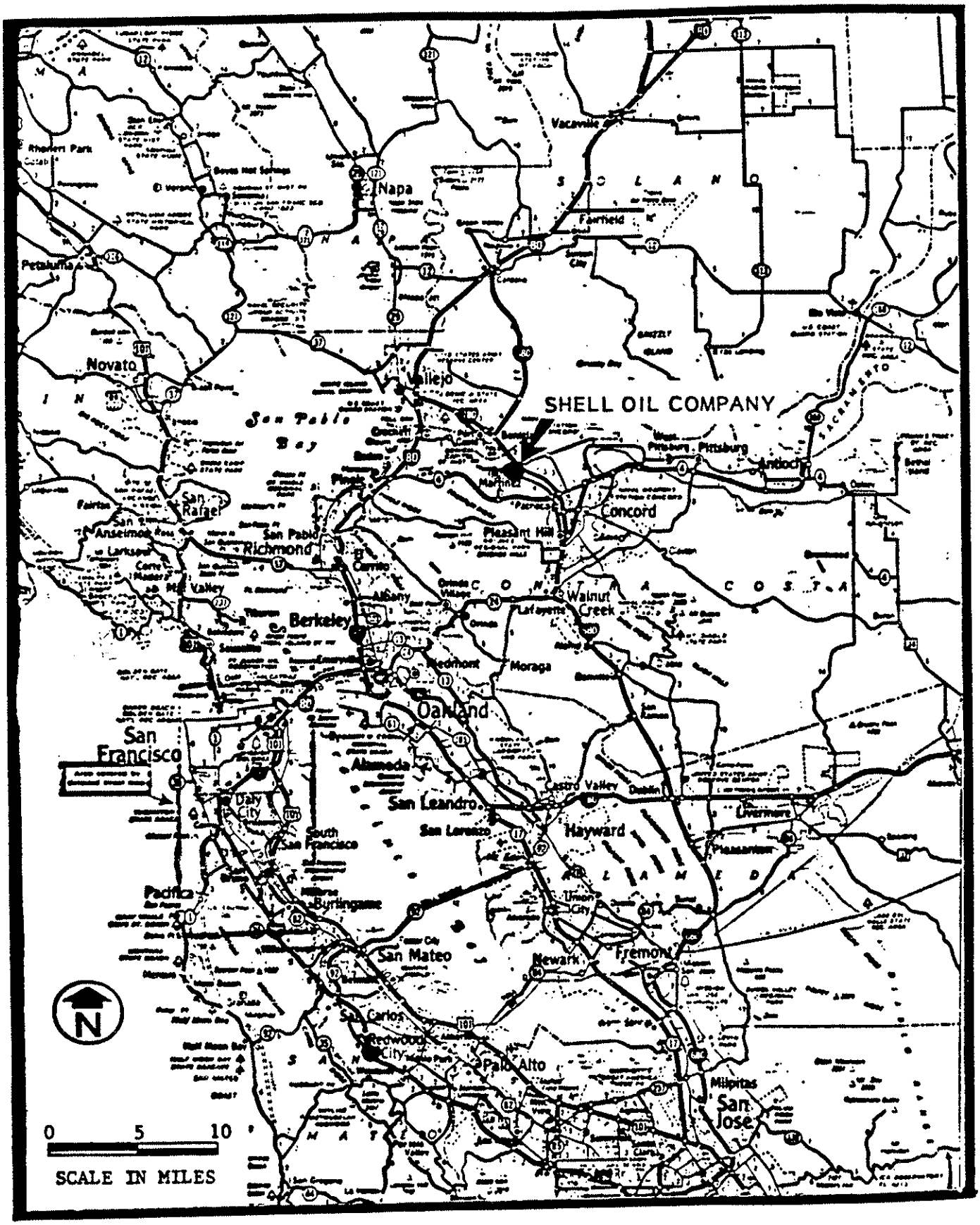


Figure 1

REGIONAL LOCATION OF SHELL OIL

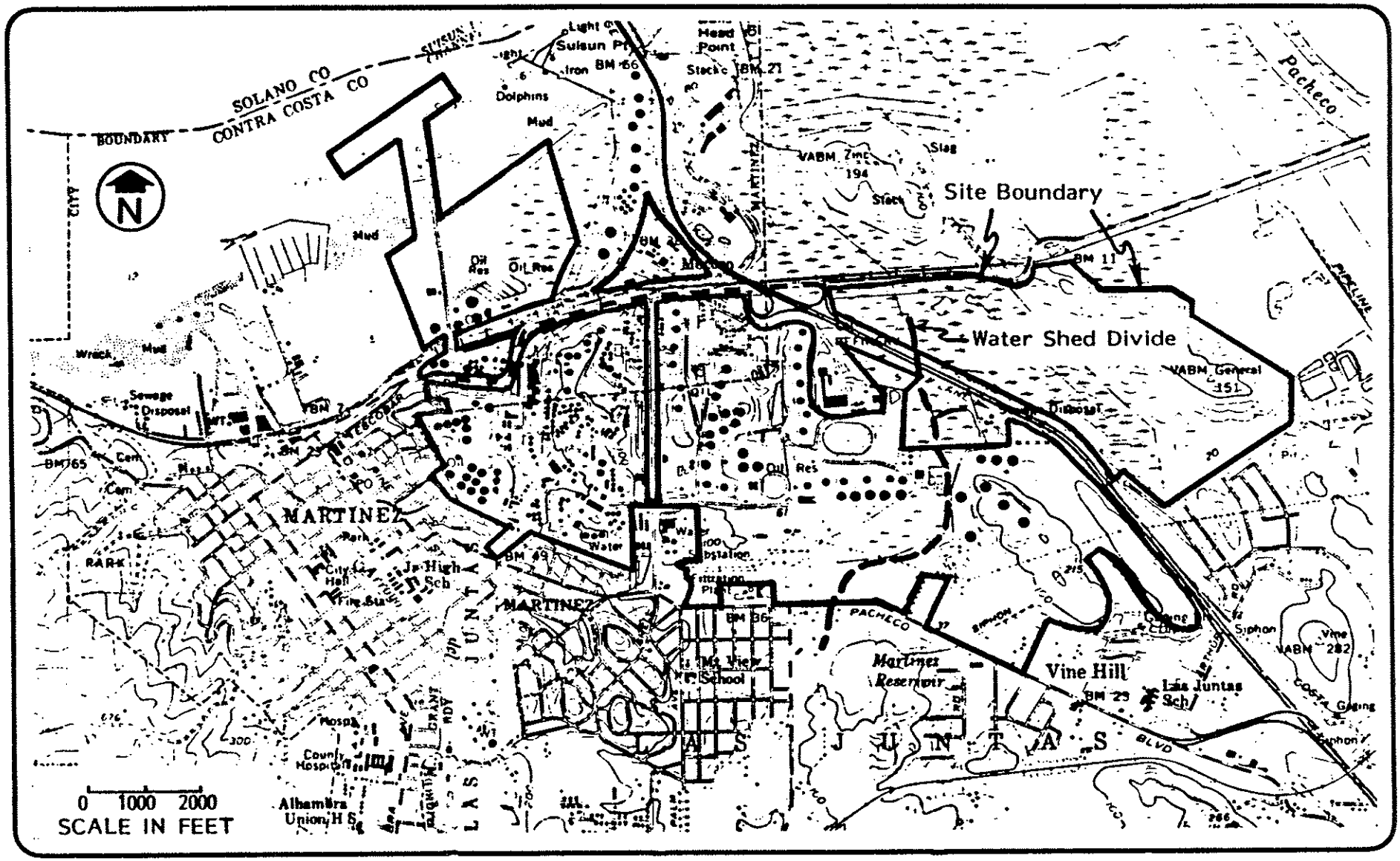
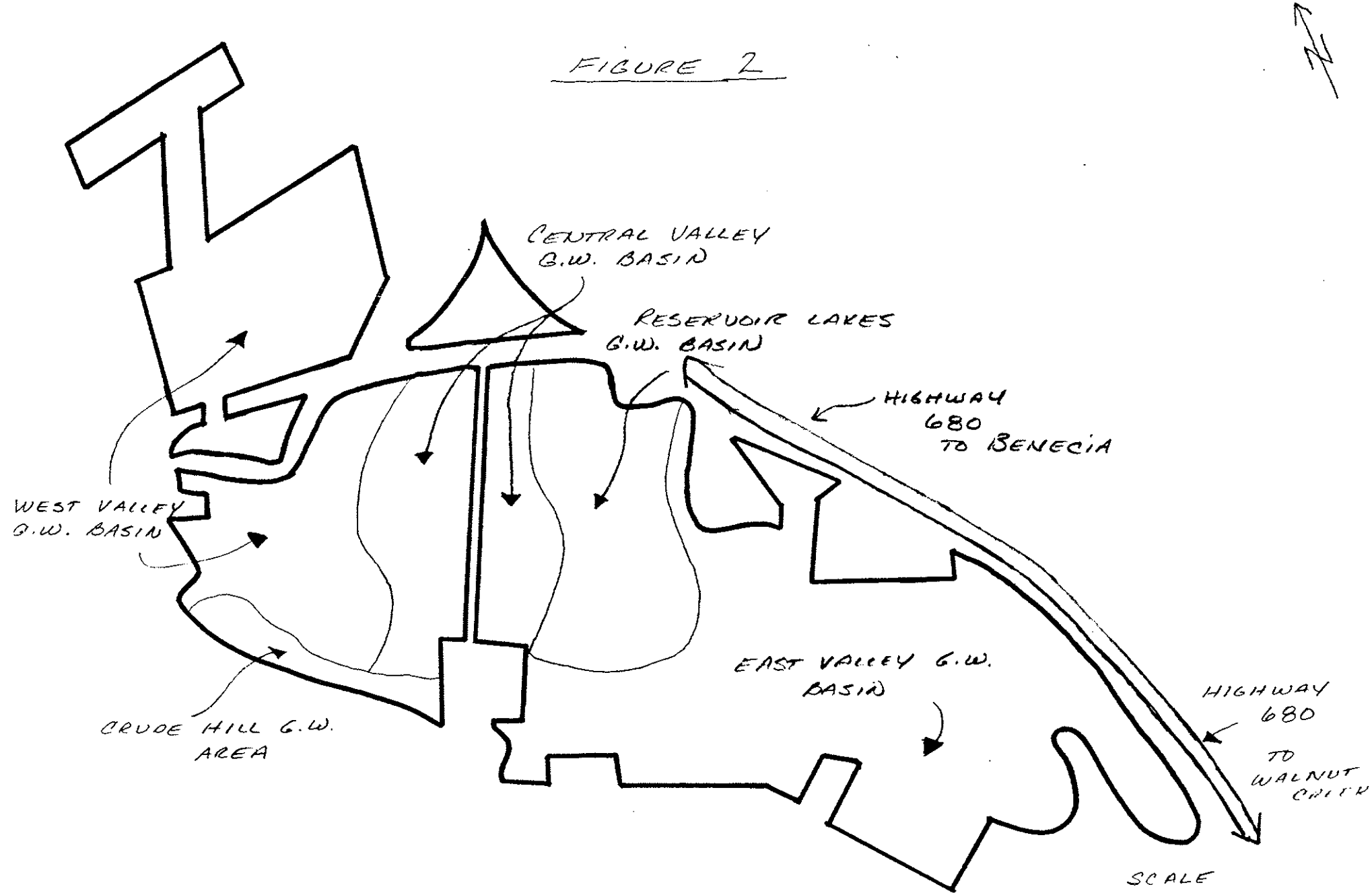


Figure 1a

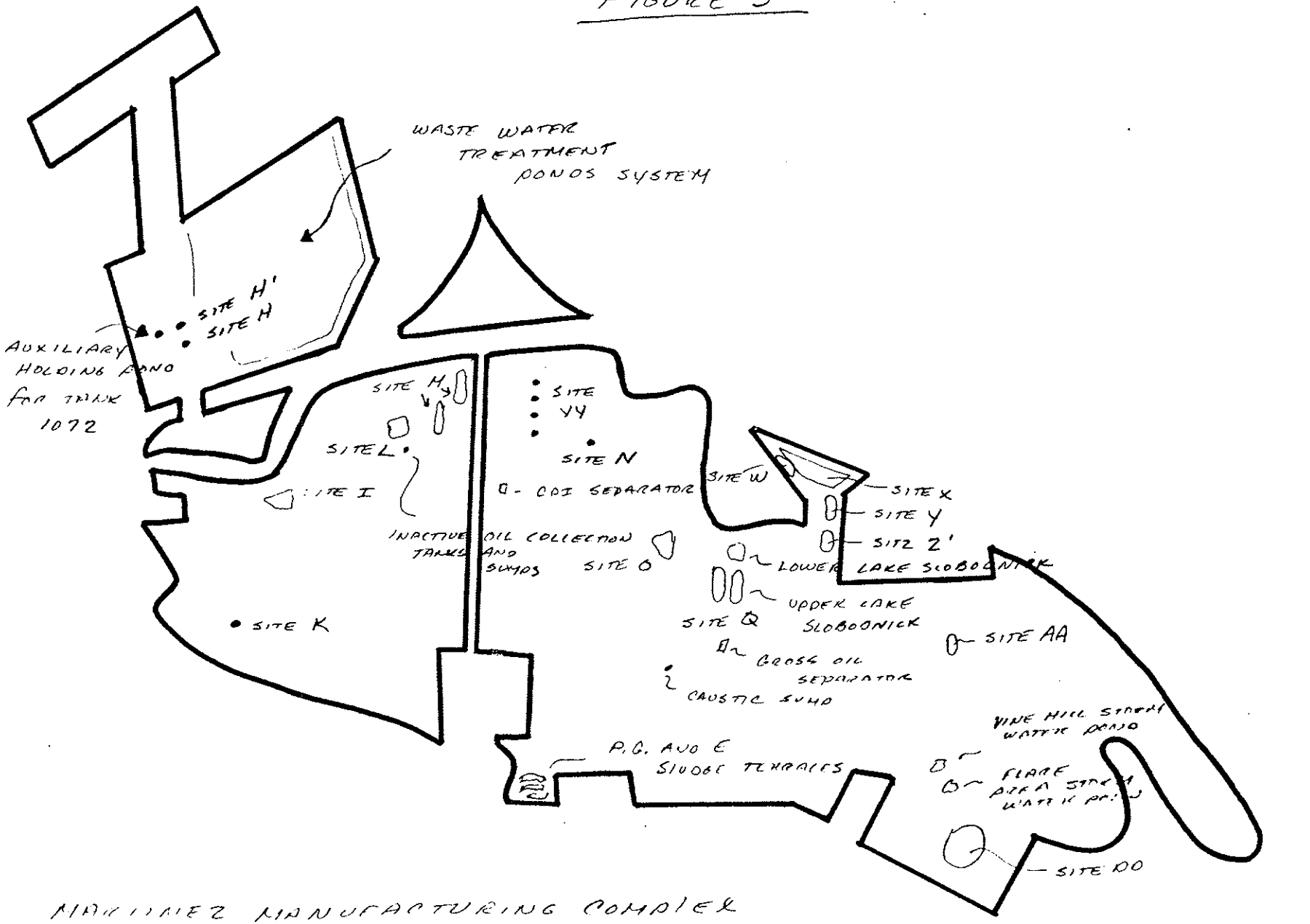
LOCATION MAP OF SHELL OIL COMPANY
Sources: USGS Benicia Quad, 1980 and Port Chicago Quad, 1968

FIGURE 2



MARTINEZ MANUFACTURING COMPLEX
GROUNDWATER BASINS LOCATION

FIGURE 3



MALLINCKRODT MANUFACTURING COMPLEX
LOCATION OF WASTE MANAGEMENT UNITS

* UNITS NOT DRAWN TO SCALE

SCALE
2000'

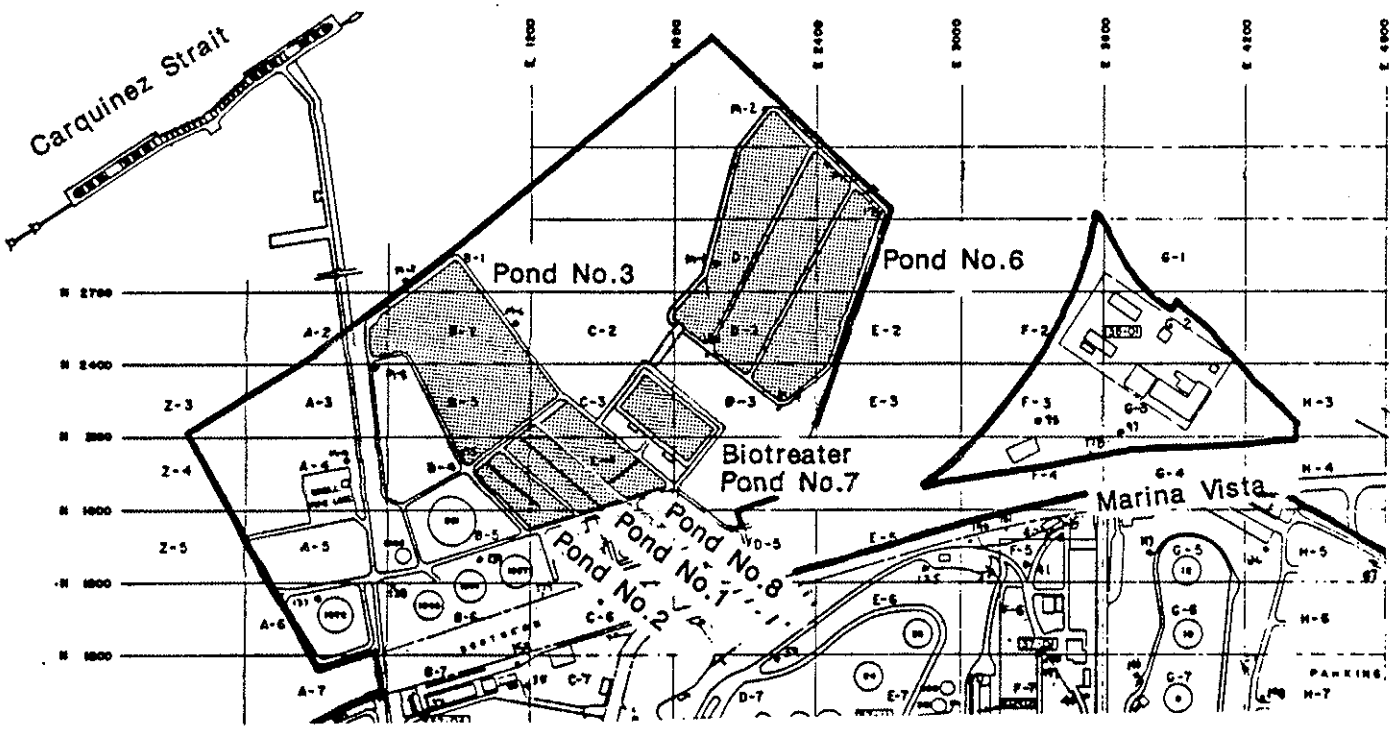
N

0 400 800 1600 F

SCALE

FIGURE 4

WASTE WATER TREATMENT POND SYSTEM
(PONDS SHADED)



APPENDIX 1

	SUBMIT ROWD PLAN	SUBMIT ROWD REPORT	SUBMIT WASTE CHAR. PLAN	SUBMIT WASTE CHAR. REPORT	SUBMIT G.W. MONIT. PLAN	ACHIEVE COMPL. MONIT. PLAN	SUBMIT CORR. ACTION PLAN	ACHIEVE COMPL. CORR. ACTION PLAN
W, X, Y	-	-	12/88	7/89	10/88	12/89	1/89	10/89
K, L, B	12/88*	4/89*	"	"	"	"	1/90	10/90
1072, I	"	"	"	"	"	"	1/91	10/91
AA, Q, O, YY, Z"	-	-	"	"	"	"	1/92	10/92
DD, H N	-	-	"	"	"	"	1/93	10/93

Note: ROWD is due for sites B and 1072 only.
The report is due on the last day of the month indicated.